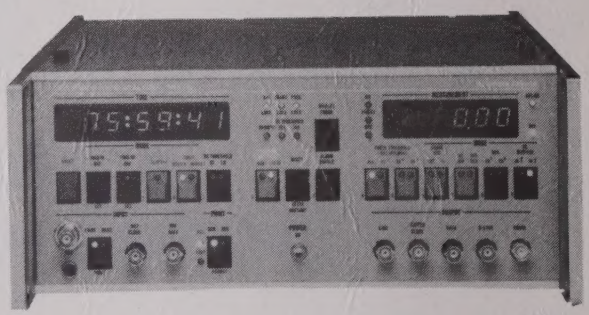
MAINTENANCE MANUAL

Model 4657B
DS3 Error Rate Analyzer



IMPORTANT NOTICE

New Manual Information and/or Documentation is provided in the back cover envelope

MP MASTER
MA29821

Scientific Atlanta

Digitized by the Internet Archive
in 2024

https://archive.org/details/manualsplus_03872

Scientific Atlanta

Model 4657B
DS3 Error Rate Analyzer

Maintenance Manual

Second Edition, Revised

July, 1986

Copyright ©1985 Scientific-Atlanta All Rights Reserved
Printed In U.S.A.

PUBLICATIONS NO. 35R053D

MANUAL PART NO. 311650

WARRANTY

Each standard catalog product manufactured by Scientific-Atlanta, Inc., is warranted to meet all published specifications and to be free from defects in material and workmanship. The company's liability under this warranty is limited to servicing or adjusting equipment and/or replacement of defective parts of any equipment returned to the factory, freight paid by buyer, within a period of one year from date of shipment from the factory, unless a shorter period is specified. Equipment showing damage by misuse, or abnormal conditions of operation, shall be excluded from this warranty. Scientific-Atlanta, Inc., shall in no event be responsible for incidental or consequential damages, including without limitation personal injury or property damage.

Tubes used in Scientific-Atlanta, Inc., equipment carry standard tube manufacturers' warranties which may be fulfilled directly from the tube manufacturer or its distributor. Microwave tubes failing within the stated warranty period should be handled directly with Scientific-Atlanta, Inc., in accordance with instructions packed with the equipment or tube. Cable and other items manufactured by others and not made an integral part of equipment of Scientific-Atlanta's manufacture shall carry the original manufacturer's warranty.

Products manufactured by Scientific-Atlanta, Inc., to customers' specifications are warranted to be free of defects in material and workmanship and shall conform to all specifications made a part of the contract or purchase order. Inspection and acceptance shall be conclusive as to fulfilling this warranty, except as to latent defects providing, however, that all claims made or to be made for any reason must be made in writing within one year of shipment from Scientific-Atlanta's plant. Scientific-Atlanta, Inc., responsibility under this warranty shall be limited to repair or replacement of defective work or parts returned to Scientific-Atlanta, Inc., with transportation charges to Scientific-Atlanta, Inc., plant and return paid by buyer. Scientific-Atlanta, Inc., may at its option elect to correct any warranty defects by sending its supervisory or technical representative at Scientific-Atlanta, Inc., expense to customer's plant or location within the continental United States to make on-site corrections. Scientific-Atlanta, Inc., shall in no event be responsible for incidental or consequential damages, including without limitation personal injury or property damage. SINCE SCIENTIFIC-ATLANTA, INC., HAS NO CONTROL OVER CONDITIONS OF USE, NO WARRANTY IS MADE OR IMPLIED AS TO SUITABILITY FOR CUSTOMER'S INTENDED USE, BEYOND SUCH PERFORMANCE SPECIFICATIONS AS ARE MADE A PART OF THE PURCHASE ORDER. THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, EXCEPT AS STATED HEREIN. This limitation on warranties shall not be modified by verbal representations.

Equipment shipped F.O.B. Scientific-Atlanta, Inc., plant shall become the property of buyer upon delivery to and receipt from carrier. Damage in shipment should be handled by the buyer directly with the carrier by immediately requesting carrier's inspection upon evidence of damage in shipment. DO NOT RETURN ANY SCIENTIFIC-ATLANTA PRODUCT TO THE FACTORY UNTIL SHIPPING INSTRUCTIONS ARE RECEIVED.

SCIENTIFIC-ATLANTA, INC.

INSTRUMENTATION

TABLE OF CONTENTS

Section		Page
	OVERVIEW	
0.1	Introduction	0-1
0.2	Technical Specifications	0-1
0.3	Front and Rear Panel Configuration	0-8
	CHAPTER 4 THEORY OF OPERATION	
4.1	General	4-1
4.2	Power Supply	4-3
	4.2.1 General	4-3
4.3	Model 4657B Error Rate Analyzer Circuits	4-6
	4.3.1 Front Panel Assembly (A5)	4-8
	4.3.2 44.736 MHz Clock Recovery PWB (A4)	4-8
	4.3.3 ECL Logic PWB (A2)	4-12
	4.3.4 Processor PWB (A1)	4-27
4.4	Model 4657B Analyzer Options	4-51
	4.4.1 Option 304281: IEEE-488 Interface Bus PWB	4-51
	4.4.2 Option 304378: RS-232C Interface Bus PWB	4-56
	4.4.3 Option Model 4650: Dot Matrix Printer	4-62
4.5	Operational Programs	4-82
	4.5.1 General	4-82
	4.5.2 Routine	4-82
	4.5.3 Memory and I/O Assignments	4-83
	4.5.4 Hardware/Software Interfacing	4-83
	4.5.5 Printer Driver	4-84

TABLE OF CONTENTS - continued

Section		Page
	CHAPTER 5 MAINTENANCE	
5.1	General	5-1
5.2	Troubleshooting - Introduction	5-1
5.3	Troubleshooting The Model 4657B Analyzer	5-2
	5.3.1 Model 4657B Analyzer Visual Inspection	5-2
	5.3.2 Model 4657B Analyzer Power Sources	5-4
	5.3.3 Model 4657B Analyzer Panel Indicators	5-7
	5.3.4 Model 4657B Analyzer Power-Up Checks	5-7
	5.3.5 Model 4657B Analyzer Self-Test	5-8
	5.3.6 Model 4657B Analyzer Real-Time Clock Reset	5-9
5.4	Model 4657B Analyzer Operational Tests	5-9
	5.4.1 Signal Loss Failure	5-12
	5.4.2 Frame Loss Failure	5-12
	5.4.3 PRBS Loss Failure	5-14
	5.4.4 Error Rate Mismatch	5-15
	5.4.5 Blue Signal Detection Malfunction	5-16
	5.4.6 Option IEEE-488 (304281) Malfunction	5-16
	5.4.7 Option RS-232 (304378) Malfunction	5-16
	5.4.8 Option Printer Model 4650 Malfunction	5-17
	5.4.9 External Event Monitor Malfunction	5-17
5.5	Calibration	5-18
	5.5.1 Test Equipment	5-18
	5.5.2 Model 4657B Analyzer Calibration	5-19
5.6	Regional Service Centers	5-21
	CHAPTER 6 PARTS LISTS	
6.1	General	6-1
6.2	Explanation of Column Headings	6-1
6.3	Ordering Parts	6-2
6.4	Parts Substitution	6-2
	CHAPTER 7 DIAGRAMS	
	Index of Diagrams	7-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
0.1	Model 4657B Front Panel Configuration	0-8
0.2	Model 4657B Rear Panel Configuration	0-9
4.1	DS3 Format	4-2
4.2	Power Supply Block Diagram	4-4
4.3	Model 4657B Block Diagram	4-7
4.4	Model 4657B Analyzer Front Panel, Block Diagram	4-8
4.5	Model 4657B 44.736 MHz Clock Recover PWB (A4), Block Diagram	4-10
4.6	ECL Logic PWB (A2) Block Diagram	4-13
4.7	Model 4657B B3ZS Decoder and Blue Signal Detector Section, ECL Logic PWB (A2), Block Diagram	4-15
4.8	Model 4657B F-Frame Synchronizer Section ECL Logic PWB (A2), Block Diagram	4-18
4.9	Model 4657B M-Frame Synchronizer Section, ECL Logic PWB (A2), Block Diagram	4-22
4.10	Model 4657B Pseudo Random Bit Sequence Generator Section, ECL Logic PWB (A2), Block Diagram	4-24
4.11	Model 4657B Million Bit Interrupt Section, ECL Logic PWB (A2), Block Diagram	4-26
4.12	Model 4657B Processor PWB (A1), Block Diagram	4-28
4.13	Model 4657B Processor PWB (A1), Memory Map	4-30
4.14	Model 4657B Real-Time Clock Burst Counter, Power Fail, and Dead-Man Timer Circuitry, Block Diagram	4-36
4.15	MM58167 Microprocessor Compatible Real-Time Clock (8 Sheets)	4-37

LIST OF ILLUSTRATIONS - continued

Figure	Title	Page
4.16	Model 4657B Processor PWB (A1) Bit Error Counter, Million Bit Interrupt Latch and External Event Monitor Circuitry, Block Diagram	4-46
4.17	Model 4657B Processor PWB, BPV and Parity Error Counters Circuitry, Block Diagram	4-49
4.18	Model 4657B IEEE-488 Interface PWB (A6) (Option 304281), Block Diagram	4-52
4.19	Model 4657B RS-232C Interface PWB (Option 304378), Block Diagram	4-58
4.20	Dot Matrix Printer, Timing Sequence for Writing Character Data	4-63
4.21	Dot Matrix Printer, Control/Drive Card, Block Diagram	4-64
4.22	Dot Matrix Printer, General Interface Functions of the Control/Drive Card Connectors, Block Diagram	4-70
4.23	Dot Matrix Printer, Dimensions of the Control/ Drive Card	4-72
4.24	Control/Drive Card for Dot Matrix Printer Model 822-08A, Component Location	4-76
4.25	Control/Drive Card for Dot Matrix Model 822-08A, Schematic Diagram	4-77
4.26	Control/Drive Card for Dot Matrix Printer Model 822-08B, Component Location	4-79
4.27	Control/Drive Card for Dot Matrix Model 822-08B, Schematic Diagram	4-80
5.1	Troubleshooting Flow Chart	5-3
5.2	Selecting the Proper Operating Voltage	5-6
5.3	Troubleshooting Flow Chart Using Operational Tests (2 Sheets)	5-10

LIST OF TABLES

Table	Title	Page
4.1	Model 4657B Analyzer, Operation Program I/O Assignments	4-31
4.2	Dot Matrix Printer, Control/Drive Card Connector Pinout Identification	4-68
4.3	Dot Matrix Printer, Character Coding Set	4-71
5.1	Test Equipment	5-18

OVERVIEW

0.1 INTRODUCTION

The Scientific-Atlanta Model 4657B Error Rate Analyzer is supplied with two manuals: the Operator's and the Maintenance. This Maintenance manual provides technical information such as theory of operation, service maintenance procedures, parts listings, printed circuit board layouts and schematics, and is designed to be used in conjunction with the Operator's manual. However, some of the more frequently referred to information (from the Operator's manual) is reprinted in this Overview section in case the Operator's manual is not readily available.

NOTE

Maintenance or service of this equipment must be performed only by trained service personnel who are aware of the hazards involved, such as fire and electrical shock.

0.2 TECHNICAL CHARACTERISTICS

A summary of technical characteristics for the Model 4657B Error Rate Analyzer components is provided in the following specifications:

B3ZS Input (bipolar signal)	
Rate:	44.736 (±0.1) Mbit/S
Impedance:	75 ohms
Return loss:	Greater than 20 dB for a 3 nS rise time pulse
Connector:	Accepts a WECo 440 type or BNC
Sensitivity:	Switch selectable (HI/LO and DSX-3) to match the available signal:
HI/LO:	Operates to 22 dB below DSX level
Sensitivity (con't):	DSX-3: Provides compensation for a DS3 data signal passed through 450 feet of type 728A cable
Pulse Characteristics	
Width: 11.2 (±1.1) nS	
Rise/fall:	4.5 (±1.5) nS
Signal Format:	Bipolar B3ZS with or without DS3 framing bits
NRZ Input (unipolar signal)	
INPUT - CLOCK	
Connector:	BNC type
Impedance:	75 ohms, ac or dc coupled, jumper selectable
Frequency:	10 to 50 MHz, 1.0 to 2.0 volts peak-to-peak
INPUT - DATA	
Connector:	BNC type
Impedance:	75 ohms, dc coupled, selectable for 10K type ECL, TTL, or 2 volt bipolar centered about 0 volts. Level and data polarity selection is by means of an internal jumper.
Signal format:	Unipolar NRZ with or without DS3 framing structure
INPUT - External Event Monitor	
Connector:	9 pin D-type
DC Voltage:	Two inputs accomodate voltages from -40.00V dc to +40.00V dc.
Dry Contact:	Two inputs sense open- and short-circuit.

Synchronization (any input type)	
Framing:	Automatically accommodates to data patterns with or without the framing structure by searching for a PRBS pattern if unable to detect framing. This search operation is disabled during a test.
Definitions:	
"In Sync":	F-Frame = 15 successive F-bits agree with the predicted pattern M-Frame = 2 successive "010" sequences are found
"Out of Sync":	F-Frame = 3 out of 15 F-bits are incorrect M-Frame = 2 out of 3 "010" sequences are in error
Measurement Modes	
Types of Errors:	Measurements are concurrently made on the three possible error types, any one of which may be selected for display.
Bit Errors:	Detected by comparing the incoming data pattern with the output of an internal PRBS generator (available only with PRBS data pattern)
Parity Errors:	Detected by comparing the incoming parity bits with internally computed parity (available only with framed data)
Bipolar Violations:	Detected by keeping track of the alternate mark inversion sequence in incoming B3ZS data (not available with NRZ)
Error Measurements:	From the acquired data, several measurement values may be computed for display
Bit Error Rate (BER) Per 10^7 Bits:	Counts the number of errors in a sample of 10^7 bits and divides the result by 10^7, updating the display every 0.22 seconds
Bit Error Rate (BER) Per 10^8 Bits:	Counts the number of errors in a sample of 10^8 bits and divides the result by 10^8, updating the display every 2.2 seconds
Error Threshold:	During a timed test, one of 4 selectable error thresholds is used to classify error-seconds data: ALL (0), 10^{-7}, 10^{-6}, and 10^{-3}. To be counted at a given threshold, an error must fall in a one-second interval for which the BER exceeds the selected threshold. The one-second intervals may be synchronized to

	incoming errors (SYNCHRONOUS ERROR-SECONDS) or be tied to the internal clock (ASYNCHRONOUS ERROR-SECONDS) by means of an internal jumper.
Total Error-Seconds:	Number of seconds during the timed test for which the BER exceeded the selected threshold.
% Error-Seconds:	Error-Seconds expressed as a percentage of seconds in the test.
% Error-Free Seconds:	The percentage of seconds during a timed test in which no errors occurred for the specific error type and threshold. (Only available on the Model 4650 printer or remote interface.)
Total Errors:	Total number of errors which occurred during Error-Seconds for which the BER exceeded the selected threshold since the start of the test.
Average Bit Error Rate (BER):	Total errors exceeding the selected threshold divided by the total number of bits received during a test.
Error Bursts:	Available only with 4650 Printer or one of the remote interfaces (IEEE-488 or RS-232C). An error burst is a group of one or more contiguous "Error Milliseconds". The number of bursts in each of three length catagories is tabulated (1-9, 10-99, and ≥ 100) for the error type selected when entering run mode.
Frame Loss Seconds:	Available only with 4650 printer or one of the remote interfaces (IEEE-488 or RS-232C). When a frame loss is encountered, the loss seconds are counted. The data from these seconds is excluded from all other error measurements except 10^7 BER and 10^8 BER. IF there is frame loss when entering run mode, this feature is disabled.
Signal Loss Seconds:	Available only with 4650 printer or one of the remote interfaces (IEEE-488 or RS-232C). When a signal loss is encountered, the loss seconds are counted. The data from these seconds is excluded from all other error measurements except 10^7 BER and 10^8 BER.
DC Monitor:	Two DC VOLTAGE inputs and two DRY CONTACT inputs can be monitored. The first display position in the MEASUREMENT DISPLAY contains the status of the selected DRY CONTACT input

DC Monitor - (continued)	(blank = Inactive, A = Active, and H = has been active during the timed test). The remainder of the display shows DC Voltage for the selected input. If the 4650 printer or one of the remote interfaces is also available, out of threshold seconds for each channel is available along with the error quantities of each type for each channel out of threshold.
Indicators	
PRBS Frame Loss:	On when synchronization between the local PRBS generator and the incoming data pattern is not achieved. (More than 1023 errors in 32767 bits.) Blinks at end of a timed test to indicate loss during the test.
Gating:	On, indicates that a measurement is underway. Blinks to indicate display update.
Signal Loss:	On when input data is lost for more than 22 ms. Blinks at end of a timed test to indicate loss during the test.
Frame Loss:	On when framing is not present in the input signal, or was not present when a timed test began. Blinks at end of a timed test to indicate loss during the test.
Remote:	On when a remote device is controlling the 4657B Analyzer via the IEEE-488 or RS-232C option.
Run/Stop:	Red indicates Stop mode; green indicates Run mode. If, during a timed test (Run mode) a test fault condition is encountered (power loss, signal loss, frame loss, PRBS loss, dc out of threshold, or dry contact alarm), the green Run indicator will flash. When the test ends or is stopped, the respective indicators will flash, with the red Stop indicator flashing to indicate power loss.
IN 1 and IN 2 Out of Threshold:	On when DC VOLTAGE for respective input exceeds programmed upper threshold or is less than programmed lower threshold. Blinks at end of a timed test to indicate out of threshold during the test.
Time Display:	Seven-digit numeric display shows time of day, month/day, elapsed time, time remaining in test, or dc voltage thresholds as indicated by the associated mode indicators. Time

Indicators (continued)	keeping is accomplished by means of a real-time clock circuit which is backed up by a Ni-Cad battery to permit timekeeping in the absence of external power, and recovery upon re-application of power. Voltage thresholds from -40.00 to 40.00 may be entered in the TIME display for the DC MONITOR function.
Measurement Display:	
Error Rates	1.0000 to 1.0 x 10^{-50}
Counts (error-seconds and total errors)	0 to 999,999 in decimal notation then 1.000 x 10^{6} to 9.99 x 10^{50} in scientific notation.
DC Monitor	Leftmost display position is status of selected DRY CONTACT input (blank = Inactive, A = Active, H = has been active during the test). The rest of display is dc voltage from -40.00 to 40.00. Input 1 data is displayed only if DC MONITOR IN 1 is selected and input 2 data is displayed only if DC MONITOR IN 2 is selected.
Measurement Ranges	
Bit Errors Rate: Bipolar Violations Rate:	2.0 x 10^{-2} to 1.0 x 10^{-50} 2.0 x 10^{-3} to 1.0 x 10^{-50}
Parity Error Rate:	2.1 x 10^{-4} (all errors) to 1.0 x 10^{-50}
Total Errors, Error-Seconds	0 to 999 x 10^{50}
DC Voltage:	-40.00 to +40.00 (±0.40V)
BLUE Signal display:	The characters "BLUE" in the measurement display in the RUN mode and BIT ERROR mode.
General Features	
Power Supply:	Operates from either line voltage of 115/230V ac (±10%), 50 to 60 Hz, or station battery of -22V dc to -28V dc, -44V dc to -56 V dc with positive ground.
Power Dissipation:	80 Watts
Weight:	6.8 kilograms (15 pounds)
Dimensions:	33.0 cm W x 38.1 cm D x 13.3 cm H (13 in. W x 15 in. D x 5.25 in. H)
Temperature:	Operating: 0° to +50°C Storage: -40° to +65°C

MODEL 4650 PRINTER (OPTIONAL)

Interface Format:	Parallel input, eight-bit-parallel/character serial, standard ASCII format, 21 characters/ line
Modes:	ALL or Partial printout modes selectable on the 4657B Analyzer (displays Error Burst Data in ALL mode). For tests greater than 5 minutes, summary printouts (test ending and force prints) will be ALL format. Conditions which trigger printout selectable on the 4657B Analyzer front panel. Printout may be triggered by (a) Bit Error Rate greater than selected threshold, a frame loss second, or a signal loss second, (b) a dc voltage input going out of threshold, or (c) any of these conditions. Logs on Error-Second until 10 consecutive Error-Seconds are encountered. Logs on PRINT command from front panel of the 4657B or from the remote interface. Logs at end of test.
Power	Derived from the 4657B Analyzer through interface cable.

0.3 FRONT AND REAR PANEL CONFIGURATION

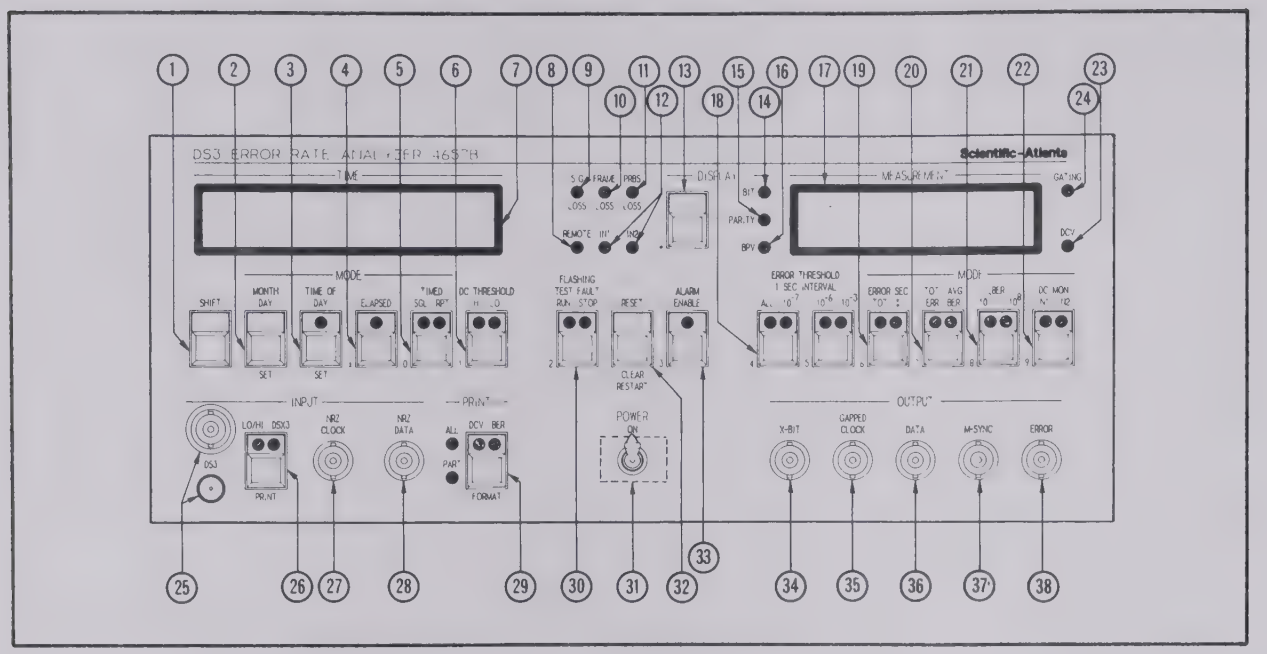


Figure 0.1. Model 4657B Front Panel Configuration

Reference No.	Panel Decal	Reference No.	Panel Decal
1	SHIFT	21	MEASUREMENT MODE BER $10^{7}/10^{8}$
2	TIME MODE MONTH DAY	22	MEASUREMENT MODE DC MON IN 1/IN 2
3	TIME MODE TIME OF DAY	23	DCV
4	TIME MODE ELAPSED	24	GATING
5	TIME MODE TIMED SGL/RPT	25	DS3 INPUT (2)
6	DC THRESHOLD HI/LO	26	INPUT LO/HI/DSX3/PRINT
7	TIME Display	27	INPUT NRZ CLOCK
8	REMOTE	28	INPUT NRZ DATA
9	SIG LOSS	29	PRINT DCV / BER / ALL/PRT / FORMAT
10	FRAME LOSS	30	FLASHING TEST FAULT RUN/STOP
11	PRBS LOSS	31	POWER ON
12	IN 1 IN 2 (DC THRESHOLD)	32	RESET/CLEAR - RESTART
13	DISPLAY	33	ALARM ENABLE
14	BIT	34	OUTPUT X-BIT
15	PARITY	35	OUTPUT GAPPED CLOCK
16	BPV	36	OUTPUT DATA
17	MEASUREMENT Display	37	OUTPUT M-SYNC
18	ERROR THRESHOLD Switches (2)	38	OUTPUT ERROR
19	MEASUREMENT MODE TOT/% ERROR SEC		
20	MEASUREMENT MODE TOT ERR/AUG BER		

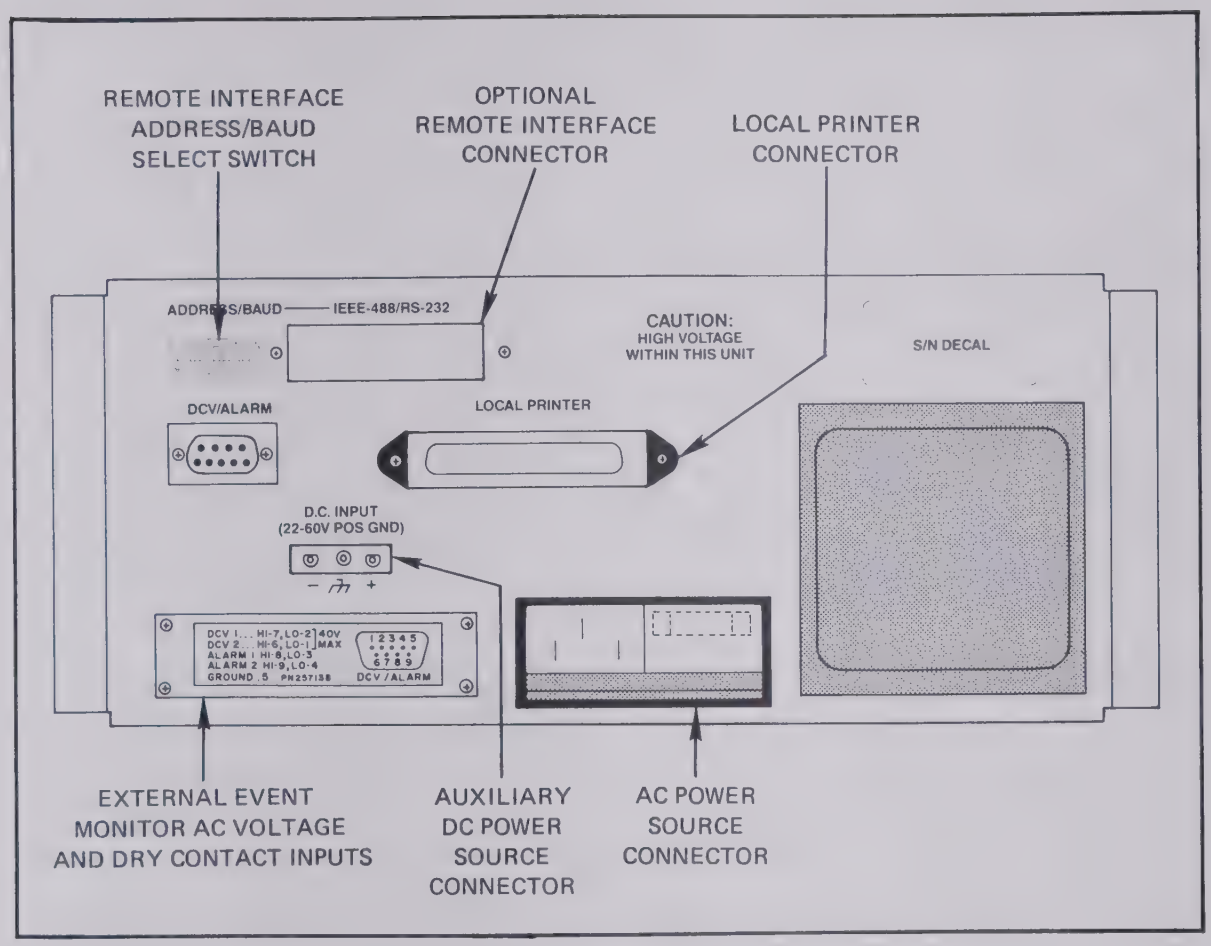


Figure 0.2. Model 4657B Rear Panel Configuration

CHAPTER 4
THEORY OF OPERATION

4.1 GENERAL

Theory of operation for the Model 4657B Error Rate Analyzer system is presented in two parts; part one describes the power supply, while part two describes features and functions. The power supply is described in a separate section because the dc supply used in this system operates independently from the other circuits.

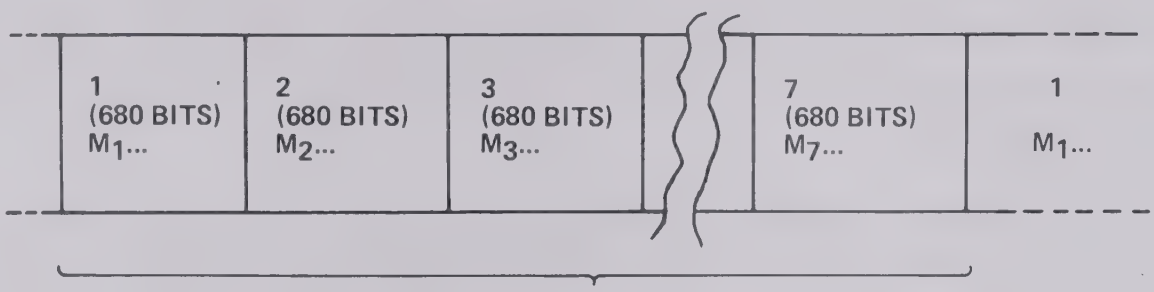
The Model 4657B Analyzer receives Bell System DS3 formatted digital signal in either a bipolar with 3-zero substitution arrangement or a non-return to zero (NRZ) arrangement with separate clock and data lines. Figure 4.1 outlines key features of the DS3 signal format on which the Model 4657B Analyzer operates. Within this format, a transmitter (the Model 4651B for instance) can send a data pattern of all 1's, all 0's, alternate 1's and 0's (...10101...), or a repeating pseudo random bit sequence (PRBS) of 32767 bits. The selected data pattern alone can be sent by disabling the framing bits. The analyzer, in turn, is capable of determining the presence or absence of a framing pattern and locking onto a PRBS or alternating 1's and 0's pattern. If the PRBS is detected, bit errors are measured, while the ...10101... pattern results in a "BLUE" signal display. If framing is present, parity errors are detected and measured. This feature makes it possible to measure error rates on live traffic.

The Model 4657B Analyzer provides two dc voltage inputs for measuring the AGC voltage, and two "dry contact" inputs for monitoring the status of the alarms. Thresholds for the dc inputs are programmable such that any excursions above or below the selected threshold points will actuate a front panel indicator and trigger a printout on the Model 4650 Printer.

TYPICAL 680 BIT DISTRIBUTION PER F-FRAME OF DATA SIGNAL

Mn 84I F_1 84I C_i 84I F_0 84I C_i 84I F_0 84I C_i 84I F_1 84I

LEGEND: Mn; WHERE n = 1, 2, 3, 4, 5, 6, OR 7
F_1, F_0, F_0, F_1; LOCATION OF BITS 1, 0, 0, 1
C_i; LOCATION OF EITHER A "111" OR A "000"
84I; LOCATION OF 84 INFORMATION BITS



TYPICAL 4760 BIT DISTRIBUTION PER SUPERFRAME

LEGEND: M_1, M_2, THROUGH M_7 = XXPP010
(NOTE THAT ONLY ONE M-BIT OCCURS PER F-FRAME SEQUENCE.)
WHERE: XX REPRESENTS EITHER 00 or 11,
PP REPRESENTS EVEN PARITY FOR 4760 DATA BITS,
$C_iC_iC_i$ REPRESENTS EITHER 111 or 000 WITHIN AN F-FRAME.
(C BITS WITHIN AN F-FRAME ARE THE SAME AND HAVE THE PATTERN OF 001001001001001011 OVER AN 18 F-FRAME SEQUENCE.)

OPERATIONAL NOTES:

1. PARITY IS CALCULATED ON THE INFORMATION BITS FROM M_1 TO M_1. THIS CALCULATION IS THEN INSERTED INTO M_3 AND M_4 IN THE FOLLOWING SUPERFRAME. PARITY BITS ARE 11 FOR THE SUM OF I-BITS EQUAL TO 1, AND 00 FOR THE SUM OF I-BITS EQUAL TO 0.
2. THE ANALYZER DECLARES F-BITS ARE "IN-FRAME" WHEN 15 SUCCESSIVE F-BITS AGREE WITH THE PREDICTED PATTERN, AND DECLARES "OUT-OF-FRAME" WHEN 3 OUT OF 15 F-BITS ARE INCORRECT.
3. THE ANALYZER DECLARES M-BITS ARE "IN-FRAME" WHEN TWO SUCCESSIVE "010" SEQUENCES ARE FOUND, AND DECLARES "OUT-OF-FRAME" WHEN 2 OUT OF 3 "010" SEQUENCES ARE INCORRECT.

Figure 4.1. DS3 Format

4.2 POWER SUPPLY

4.2.1 General

Source power for the dc supplies may be supplied from a 115/230V, 50/60 Hz ac line and/or from a -22V to -60V dc positive ground station battery. A block diagram of the power supply is shown in Figure 4.2. The schematic is shown in Figure 7.7.

4.2.1.1 Raw DC From AC Source

The raw dc source supplies input power to the regulation circuitry and to the fan circuitry. When supplied from 115/230V ac source the raw dc is approximately 300V dc. When supplied from a -22V to -60V dc source the raw dc is approximately 250V dc. When connected to both ac and dc sources the raw dc will be supplied by the source supplying the highest potential. This allows uninterruptable operation of the unit since the ac source will normally supply power, but the dc source will take over if the ac fails.

When the unit operates from a 230V ac source, CR1 acts as a bridge rectifier to produce the raw dc of about 300V. When operating from a 115V ac source, half of CR1 along with capacitors C7 and C8 form a voltage doubler to produce the 300V raw dc. The ac input power is filtered by L1 and capacitors C1 through C6. Thermistors RT1 and RT2 limit the ac surge current at turn-on to prevent welding of the power switch contacts. Varistor CR2 suppresses transients on the raw dc.

4.2.1.2 Raw DC From DC Source

The 300V raw dc can also be generated from a -22V to -60V dc source. A push-pull Pulse Width Modulator (PWM) regulator consisting of U12, Q9, Q10, Q11, Q12, T4, and associated circuitry generate an ac voltage from the -22 to -60V dc input. Diodes CR42 through CR45 form a bridge rectifier to convert the ac to the raw dc of approximately 250V. The output voltage is sampled by

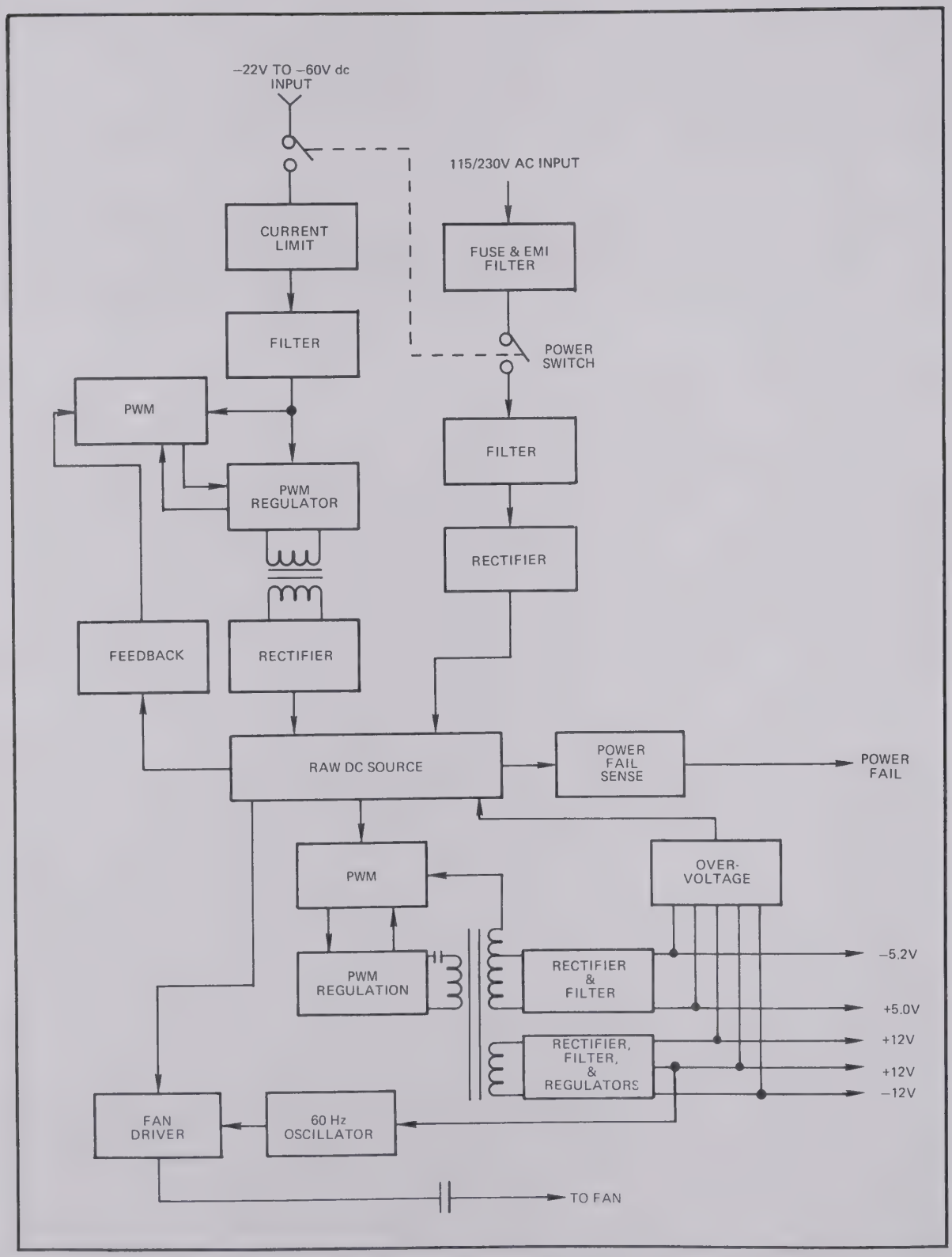


Figure 4.2. Power Supply Block Diagram

CR46, CR47, CR48 and opto-isolator U13 and fed back to U12 to regulate the voltage.

Q5 and its associated components limits the dc current inrush to prevent welding of the power switch contacts. When power is applied, Q5 turns on slowly to limit the current.

4.2.1.3 PWM and Voltage Regulators

The dc voltages for the unit are generated from the raw dc by a combination of a switching type supply and linear regulators. PWM IC U1 drives transformer T1, which in turn drives MOSFETs Q3 and Q4 which switch the raw dc through transformer T3. U1 varies the duty cycle of a fixed frequency pulse stream to produce an adjustable regulated output voltage. T2 senses the current flowing through T3 and feeds back to U1 to provide current limiting. T3 has two secondaries. The output of one is rectified by CR14, CR15, CR16, and CR17 to produce the +5.0V and -5.2V outputs. L2, L3, and C23-C26 filter the outputs. CR18 and CR19 provide overvoltage protection. The -5.2V is sensed by U11B and fed back to the PWM (U1) by U7. This allows the PWM to maintain voltage regulation.

The other secondary of T3 is rectified by CR20-CR23 to provide the source for the +12V and -12V regulators. L4 and C28 filter the +12V source. Regulator U4 supplies +12V for the printer in the Model 4657B, and is not used in other units. U5 supplies +12V for the rest of the circuits. The -12V output is filtered by L5 and C30 and regulated by U6. CR25, CR27, and CR29 provide overvoltage protection. CR24, CR26, and CR28 protect the regulators from reverse voltage. Overvoltage protection is also provided by a crowbar circuit consisting of U2, CR6, and associated components. When an overvoltage is detected on any of the dc outputs, CR6 fires and shorts out the raw dc through R6. This causes the line fuse to blow to shut down the supply. The zeners on the dc outputs provide protection until the crowbar fires.

4.2.1.4 Power Fail Circuit

The power fail sense circuit consists of an opto-isolator (U3) whose LED is connected to the raw dc source through reference diodes CR8 and CR9. When the raw dc voltage falls below a level determined by the reference diodes the transistor in U3 turns on transistor Q2 which pulls the power fail line low. This signals to the CPU that power is failing. The power fail signal occurs about 15 ms before the power supply goes out of regulation.

4.2.1.5 Fan Drive Circuit

The fan drive circuit is switched by squarewave oscillator U9 at about 60 Hz. It drives transistors Q6 and Q7 which generate a 60 Hz ac for the fan by alternately charging capacitor C41 from the raw dc through the fan and then discharging the capacitor through the fan.

4.3 MODEL 4657B ERROR RATE ANALYZER CIRCUITS

A block diagram of the Model 4657B Analyzer is shown in Figure 4.3. The Model 4657B Analyzer consists of the following major assemblies and printed wiring boards:

Assemblies:	1. Rear panel and power wiring (A7)
Printed Wiring Boards:	1. 4657B Processor (A1) 2. ECL Logic (A2) 3. Power Supply (A3) 4. 44.736 MHz Clock Recovery (A4) 5. Front Panel (A5)

The Model 4657B may contain one of the following optional printed wiring boards in location A6:

1. RS-232C Interface PWB
2. IEEE-488 Bus Interface PWB

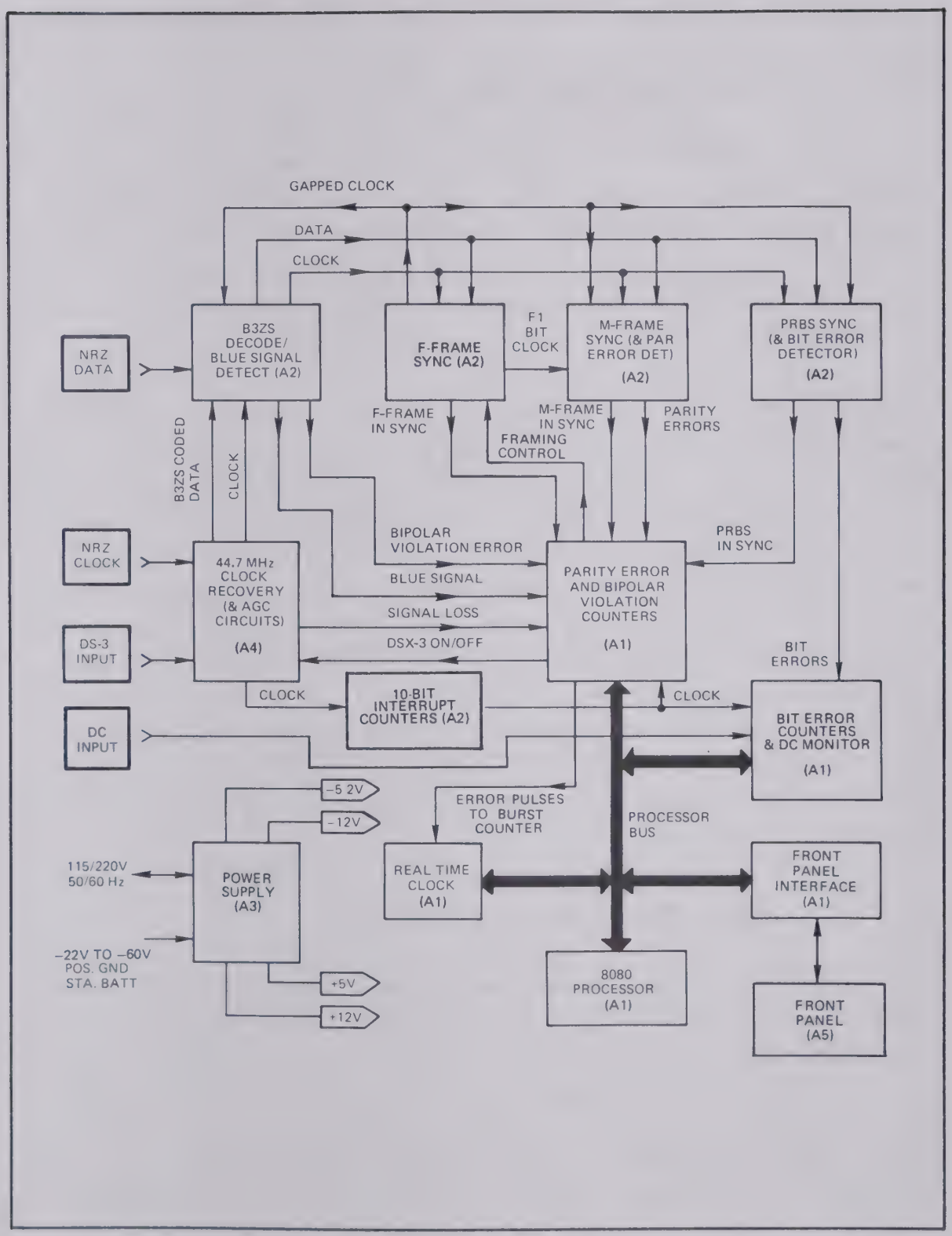


Figure 4.3. Model 4657B, Block Diagram

4.3.1 Front Panel Assembly (A5)

A block diagram of the Front Panel PWB is shown in Figure 4.4. The schematic is shown in Figure 7.11. On the front panel PWB are mounted the 7-segment displays, LEDs, switches, drivers for the displays and the alarm, and the BNC connectors. The front panel PWB also provides all of the interconnections between the Processor PWB (A1), ECL Logic PWB (A2), and the Power Supply PWB (A3).

The switches are connected in a matrix arrangement to the decoded Scan Lines (SLØ-SL3) and Return Lines (RLØ-RL7) from the 8279 (U39) on the Processor PWB (A1). The SHIFT switch (S15) is provided a separate interface line to the 8279 so it can perform a shift function for the other switches. Current source transistors in U1 and U2 (TPQ2907A) interface with the current source driver (U40) on the Processor PWB. Similarly, digit enable signals from U44 and U46 on the Processor PWB are interfaced with darlington drivers U3 and U6 (ULN2813), which drive the TIME and ERROR display digits, the alarm and 23 of the discrete LED indicators. The rest of the discrete LEDs and the colons are driven directly by latches U50 and U52 on the Processor PWB. C1, R9, R10, R11, R2, Q2 and Q3 are the drive circuit for the alarm, which is located on the Processor PWB. R14, R15, Q4, and Q5 are not normally installed.

4.3.2 44.736 MHz Clock Recovery PWB (A4)

The Clock Recovery PWB performs two basic functions: (1) provides automatic gain control (AGC) to hold a constant signal level for the data recovery circuits, and (2) extracts the 44.736 MHz clock signal to operate other circuits. The block diagram of the 44.736 MHz Clock Recovery PWB is shown in Figure 4.5 and the schematic in Figure 7.9. The major block functions are AGC/Amplifier, DSX-3 compensation network, Signal Loss detectors, External Clock Input, and Clock to bipolar data synchronization circuits.

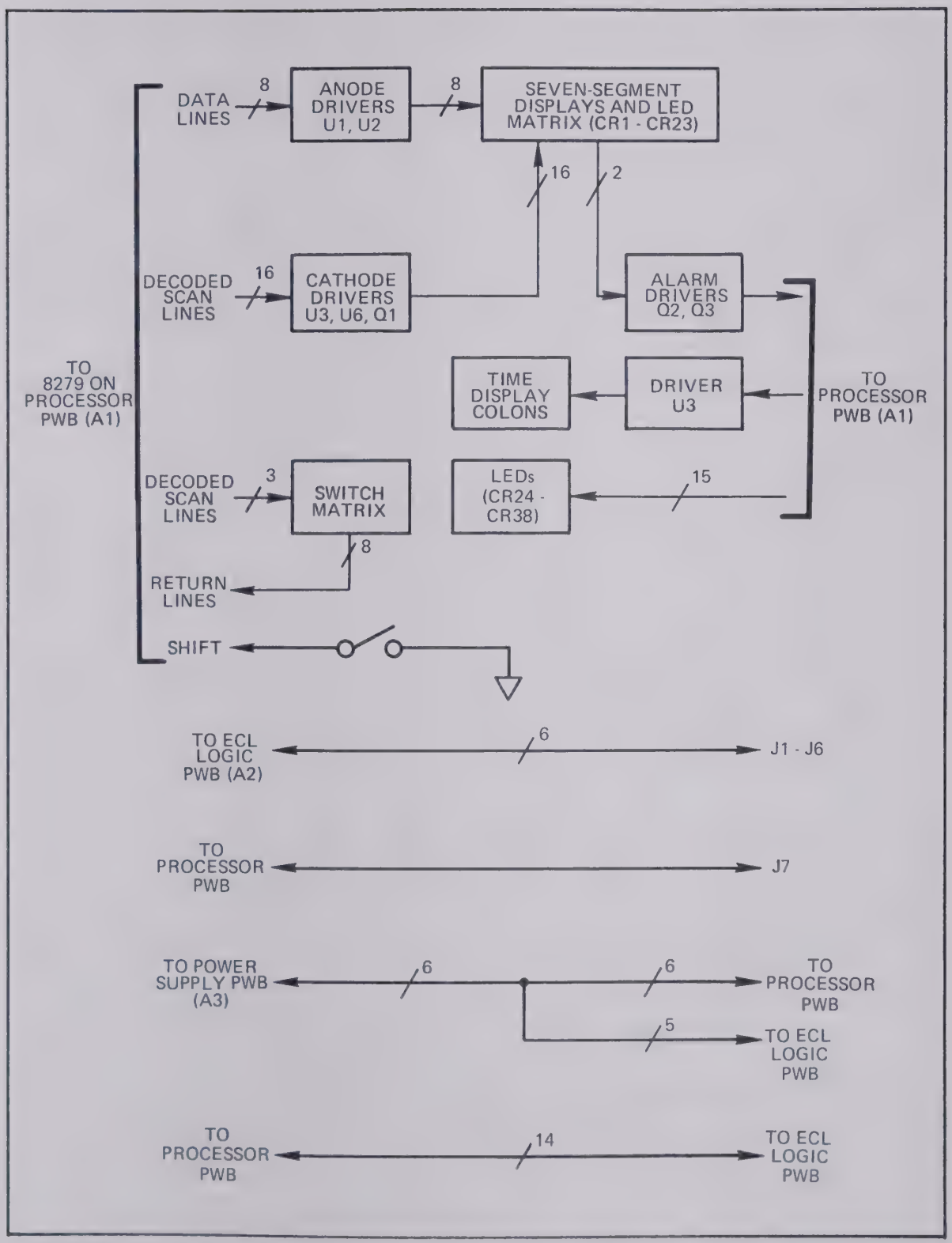


Figure 4.4. Model 4657B Analyzer Front Panel, Block Diagram

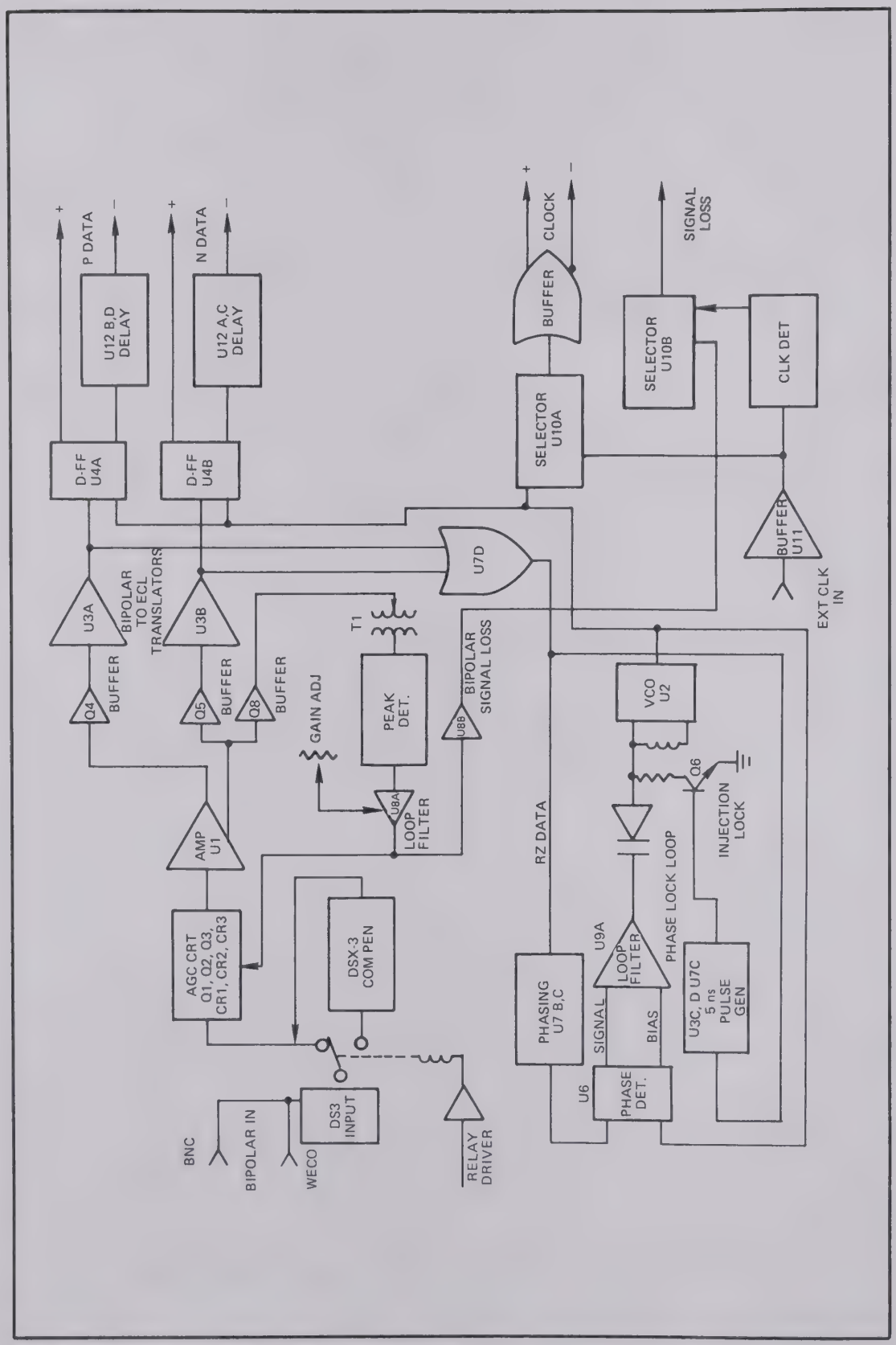


Figure 4.5. Model 4657B 44.736 MHz Clock Recovery PWB (A4), Block Diagram

The 44.736 MHz Clock Recovery PWB accepts bipolar inputs from two connectors (J1 and J3) and many levels. If the HI/LO level is selected, relay K1 directs the signal to the base of Q2. If DSX-3 is selected, K1 directs the signal through the cable compensation network (R1, R2, R3, R4, C1, L1, L2) to the base of Q2. Transistors Q2 and Q3 form a "gain control differential amplifier." The gain is set by CR1, CR2, and CR3 whose bias is controlled by Q2. The level adjusted output of Q2 is passed to amplifier U1. U1 is a wideband differential amplifier whose gain is set to be about 33 dB. Q4, Q5, and Q8 are emitter followers which buffer the amplifier output. Transistor Q8 drives transformer T1 which allows peak detection of the amplified signal by CR5 and CR6. The dc signal is filtered by C17, L6, and C18. C17 and L6 remove 44.736 MHz components. The dc peak voltage is applied to integrator U8A which produces the AGC voltage necessary to set the proper level of attenuation to maintain a constant output level. Transistors Q4 and Q5 drive line Receivers U3A and U3B which translate the bipolar signal to ECL levels representing the respective polarity of bipolar one.

The translated bipolar pulses are clocked into flip-flops U4A and U4B. The output of the flip-flops is the + and - rails of the bipolar signal in a unipolar NRZ format of ECL level. Gate U12 and components L10, L11, L12, L13, C60 and C61 provide time phasing for the following PWB.

The clock to data synchronization is performed by a combination of two methods: (1) an injection lock, and (2) a phase locked loop. The phase locked loop is a slow responding loop which is to maintain the VCO frequency at an average value of the incoming data rate. The injection lock will perform all phase updates to insure proper clock-data phasing so that proper setup intervals are maintained for flip-flops U4A and U4B.

The gates of U6 form a "missing pulse phase detector" which compares the phase of the RZ data with the clock. The in phase condition produces a symmetrical output. An error in either direction forces a change of symmetry in the output. There is a dc voltage output for no data input (phase is only updated when a data one is present). The phase detector output is fed to loop integrator U9A. U9A is also operated in a differential mode where pin 3 has a

no signal dc bias applied to it producing no change in the integrator position when no data ones are present. The lock conditions cause the symmetrical pulses which integrate to a zero average. An error signal (unsymmetrical), causes the integrator output to shift in a direction to correct the phase error.

U2 is the voltage controlled oscillator which produces the clock signal. The center frequency is generated by L7, CR10, and the voltage applied to CR10 by R68, R69, and R70. R71 applies the integrator voltage to CR10.

The injection lock portion is formed by U3C, U3D, U7C, Q6, R73, and R74. When a RZ data is detected U3C, U3D and U7C produce a 5 ns pulse which is applied to Q6. Q6 is turned on which forces the VCO output to a high state. The exact coupling between the base pulse and VCO output is determined by R73.

U11A is an ECL line receiver which functions as an external clock amplifier/buffer. Jumper J4 can be used to select between ac coupling or dc ECL. C35, R84, CR11, C36, U9B, R89, R90, CR12 are an external clock signal detector. C35, R84 place any clock signal to the cathode of CR11 which rectifies the signal and produces a dc voltage with C36. U9B amplifies the voltage producing a change of output if the current from the input voltage is greater than the bias current (from R111). R89, CR12, and R90 convert the ±12 swings to ECL levels. U10B gates the signal loss condition from the AGC with the external clock detector to form a signal loss indicator.

4.3.3 ECL Logic PWB (A2)

A block diagram of the ECL Logic PWB is shown in Figure 4.6. The schematic is shown in Figure 7.5. The ECL Logic PWB performs the high speed processing and is subdivided into five functional groups: (1) B3ZS decoder, (2) F-Frame synchronization, (3) M-Frame synchronization, (4) PRBS synchronization and error detector, and (5) Million-bit interrupt counter chain. Each section will be described individually and subdivided into its primary parts.

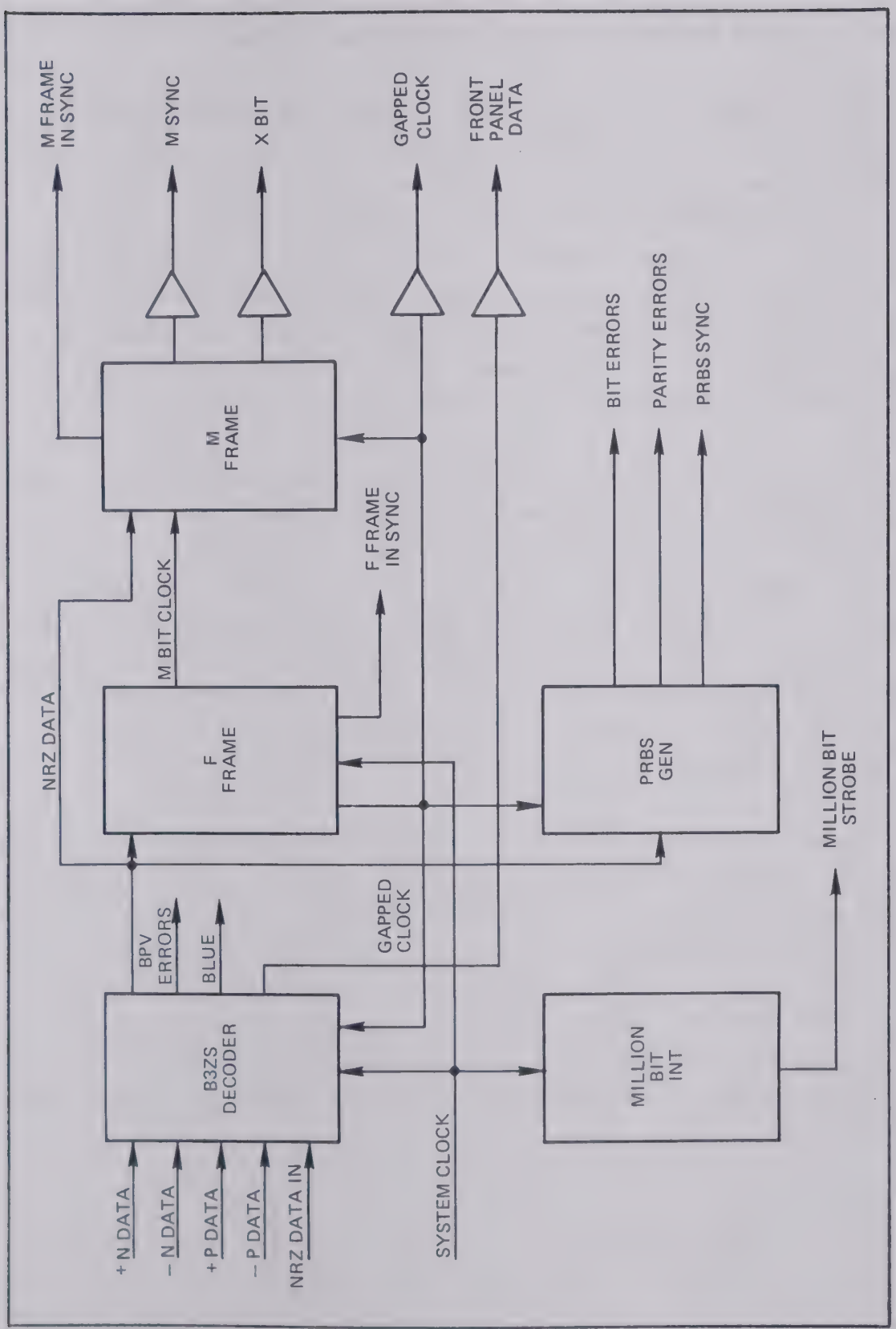


Figure 4.6. ECL Logic PWB (A2) Block Diagram

4.3.3.1 B3ZS Decoder and Blue Signal Detector Section

A block diagram of the B3ZS Decoder and Blue Signal Detector Section is shown in Figure 4.7. The primary functions of this PWB are: (1) to combine the positive and negative logic "1" pulses into a single unipolar bit stream, (2) to remove "1's" inserted for the 3-zero suppression, and (3) to detect coding or bipolar violation errors. The data streams are NOR'ed together by U1A (pin 3). This U1A output signal is the inverted combined unipolar signal with 3-zero suppression. Components U2A, U2B, and U5B form a three stage shift register. The regenerated clock signal from U6A (pin 2) is used to clock this shift register and other flip-flops in the circuit.

The gates, U1B and U3B, are used to suppress zeros when a polarity violation is detected. The flip-flop shown as U9A stores the polarity of the last "1" to enter U2A. This operation requires U4A, pin 2, to be a "1" when the signal is a positive "1", and U4A, pin 3, to be a "1" when the signal is a negative "1". Comparators U1C and U3A compare the polarity of incoming data with the polarity of the last "1" received. Two successive "1's" of the same polarity will give a logic "1" on the NOR outputs at U1, pin 14, and U3, pin 3, which will force "0's" into U2A and U5B on the next clock pulse which corrects for the suppressed "0's".

Flip-flop U4B stores the polarity of the last violation. Outputs of comparators U3C and U10A are OR connected and switch to a logic "1" if the last violation is identical to the present violation. A detected bipolar violation from U3C/U10A (pins 14 and 2) is latched into flip-flop U5A on the next clock cycle. Bipolar violation and data are differentially output to the Processor PWB (A1) for counting. The corrected data signal is applied to Level Shifter U14B where the ECL data is converted to TTL levels and buffered by a 50-ohm driver, U56A, before driving the front panel OUTPUT-DATA connector.

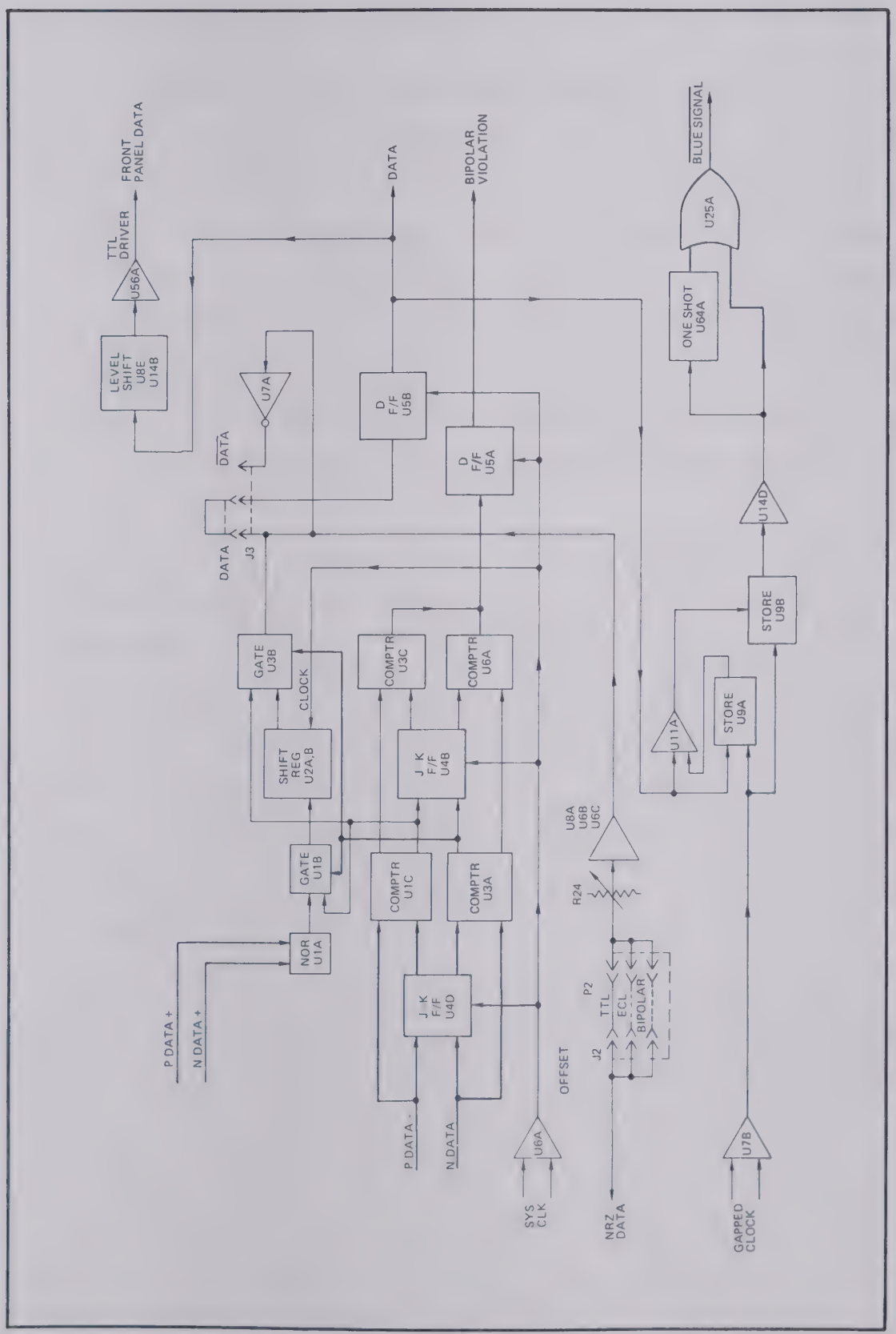


Figure 4.7. Model 4657B B3ZS Decoder and Blue Signal Detector Section, ECL Logic PWB (A2) Block Diagram

Signals from the front panel INPUT-NRZ-DATA connector are level shifted and buffered by U8A, U6B, and U6C. Using jumpers at connector J2 provides internal selection of processing Bipolar, ECL, or TTL data signals. If TTL signal levels are selected, component U8A shifts the TTL to ECL signal levels; or if ECL signal levels are selected, component U6B only buffers the signal. If bipolar signal levels are selected, the +1V/-1V inputs are level shifted by a resistor network into component U6C. The outputs of all the buffers are wire ORed and buffered again by U6D. The U6D output is wire ORed with the DS3 recovered data. If necessary for a particular test arrangement, data may be inverted by moving the jumper at connector J3. The signal is then inverted by U7A but this also inverts bipolar data and will prevent DS3 bipolar data from working correctly. Variable resistor R24 is provided with U6C to set bias on pin 11 to be 300 (±30) mV below pin 10 when BIPOLAR data is selected.

The BLUE Signal is detected by checking for a ...101010... data stream, or a data signal where each new bit is opposite of the last bit. U9A is used to store the last data bit so U11A can compare the last data bit with the new data bit. The output at U11, pin 3, is a "1" when the compared bits are different and the comparison result is stored in U9B. Both U9A and U9B are timed on the Gapped Clock signal, which is missing a clock pulse during the framing bit interval, so the BLUE Signal test will be done on data bits and exclude the framing bits. The output signal is applied to U14A which converts the ECL level to TTL level. The circuit is arranged so the output (U14, pin 4) will be a logic "0" where successive bits are opposite and a logic "1" when they are the same. An output logic "1" will trigger the One-Shot circuit of U64A and force the output (U64, pin 13) to a logic "1". Gate U25A will OR the signals of U64, pin 13, and U14, pin 4, so if either is a logic "1", the BLUE Signal will not be indicated. If U14, pin 4, remains a logic "0" and the U64A circuit times out, the output line is switched low causing a BLUE Signal indication.

4.3.3.2 F-Frame Synchronizer Section

A block diagram of the F-Frame synchronizer section is shown in Figure 4.8. The F-Frame signal is declared to be "In Sync" when 15 successive input F-bits match with a predicted pattern. The F-Frame signal is declared "Out-of-Sync" when 3 of 15 input F-bits disagree with the predicted pattern. To locate an F-bit in the data stream, a counter is started on the next data "1" presuming it to be the first bit of the ...1100... F-bit pattern. An internal counter also generates its own ...1100... sequence to be compared with the input F-bits. If an error is detected before 15 successive matches, the counters are reset and circuits wait for the next data "1". It is by this trial-and-error method that the F-Frame sequence is found. Once the F-Frame pattern is found in the incoming data, the internal counters can be synchronized and the M-bit block and the gapped or data clock can be decoded.

The J-K flip-flop, U30A, will signal other circuits when a "Data 1" has been found and also if F-bit comparison is in progress. Input data signals are regenerated by U39C and buffered by U32A and U28D into the $\overline{K}$ input of U30A, (pin 6). The next "Data 1" signal will cause the Q output, U30, pin 2, to switch from high to low. This switched function can be called "Waiting for Data 1 to Compare F-Bit State". While waiting for a "Data 1", the U30Q and $\overline{Q}$ functions will: (1) reset U40 and U41 which are the 15 successive match counters, (2) preset the counter chain of U36, U37, and U38 which generate F-Bits and the F-Bit Clock signals, (3) select the 44.7 MHz System Clock through U29C to time the U30 functions, and (4) force "In-Sync" flip-flop U35A to provide the "Out-of-Sync" signal.

To permit operation with unframed data, a control line is provided by means of which the microprocessor can force U30 to the set state. Thus the framing logic will always be "Waiting for Data 1 to Compare F-Bit State", the clock will never be gapped, and framing will never happen. This control line originates on the Processor PWB (A1).

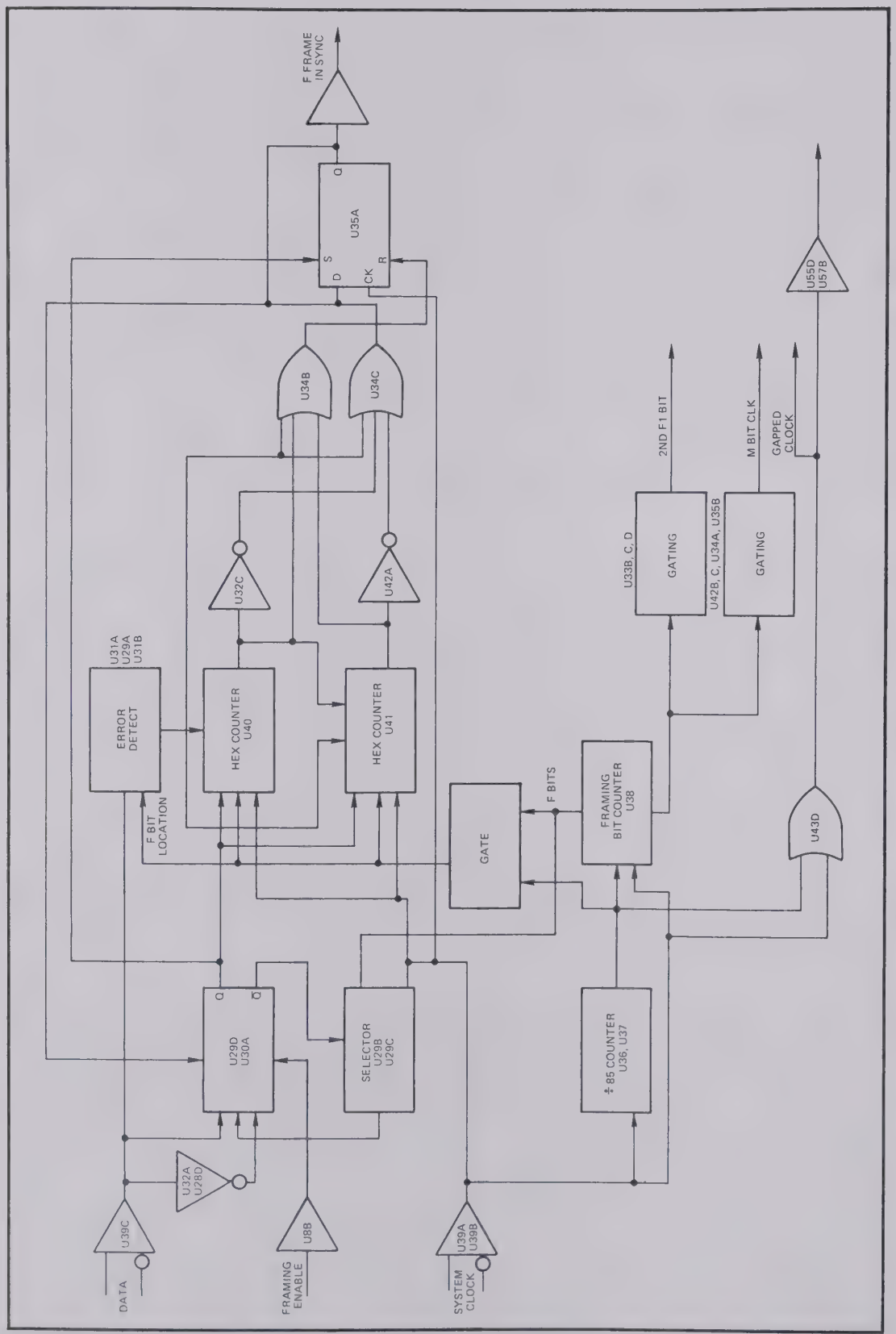


Figure 4.8. Model 4657B F-Frame Synchronizer Section ECL Logic PWB (A2), Block Diagram

After U30 switches to the "Compare F-Bit State", then: (1) counters U40 and U41 are enabled to count F-Bit matches, (2) the counter chain of U36, U37, and U38 are enabled to generate F-Bits and the F-Bit Clock, (3) component U29B selects the F-Bit Clock to time the functions of U30, and (4) the Set line of U35A is released allowing the "In Sync" signal to occur. Counters U36 and U37 divide the System Clock signal by 85. Counter U38 further divides the clock signal to generate the F-Bit Clock signal at U38, pin 3, and the F-Bit Pattern signal at U38, pin 15. The F-Bit Pattern signal is compared with the incoming data signal by the exclusive OR gate U31A. In the "Out-of-Sync" condition, component U29D passes the resultant comparison to the J input of U30 (pin 7). Since U30 is now timed by the F-Bit Clock, U30 will stay in the comparison mode if U31A indicates a match; or U30 will switch back and wait for the next "Data 1" signal if U31A indicates an F-Bit Error.

Once F-Frame Synchronization is achieved, U29D is disabled and U30 is inhibited from switching with an F-Bit Error. Signal comparison has enabled the Master Reset (MR) input to U40 which releases the MR input of U41 and normal counting modes are continued. The Clock Enable (CE) inputs on pin 6 of U40, and U41 goes low to enable U40 and U41 only during an F-Bit interval. The F-Bit interval is gated from the U36, U37, U38 counter chain by component U32B, allowing U40 and U41 to count up for each F-Bit. If an F-Bit mismatch occurs before sync is achieved, U30 will reset U40 and U41 back to zero. When 15 consecutive matches occur, U40 and U41 will reach terminal count and both $\overline{TC}$ outputs (at pin 4) will go low and switch U34B, pin 2, high. This action switches flip-flop U35A high to indicate the "F-Frame In-Sync" condition.

Once F-Frame sync is acquired, U40 and U41 are locked up at terminal count through the two $\overline{PE}$ (at pin 5) inputs until an F-Bit error occurs. The Preset inputs of U40 and U41 (pins 7, 9, 10, and 11) monitor the F-Bit comparison and can only switch to "0" during the F-Bit interval, and only if an F-Bit is in error. Both the F-Bit Interval and the F-Bit Comparison are gated by component U29A. Thus, with no errors and $\overline{PE}$ enabled, U40 is continually set to all "1's" (or the terminal count). If an error occurs, U40 is preset to "0" and starts counting back to terminal count with each F-Bit. If

another F-Bit error occurs while U40 is counting back, U41 will be preset to "0" through U32D and it will start counting back to a terminal count. If a third error occurs while U40 and U41 are counting back, this error will be gated through U34C to U35A which will clock to the "Out-of-Sync" condition on the next system clock signal.

Note that U40 will be set to "0's" as U35 switches so that 15 matches will be required before U40 can reach terminal count. If only one or two errors occur during a 15-bit interval, U40 and U41 will reach terminal count and hold while waiting for the next error. If a third error occurs after U40 has reached terminal count and U41 is still counting, then U40 will be set to "0" again but "Out-of-Sync" will not be declared. To go "Out-of-Sync" requires at least three errors in a 15 F-Bit interval.

U43D gates the system clock with the divide-by-85 output from U36 and U37 to generate the gapped or data clock. U34A gates the counter output to decode the M-Bit location. U35B resynchronizes the M-Bit with the data clock. U33B, U33C, and U33D will decode the first F-Bit after the M-Bit. This signal will be used by the M-Frame Synchronizer circuits.

4.3.3.3 M-Frame Synchronizer Section

A block diagram of the M-Frame Synchronizer Section is shown in Figure 4.9. The M-Frame Synchronizer circuits serve to synchronize the seven M-bits in a superframe and then make a parity error measurement on the data. The seven M-bits (as shown in Figure 4.9) are represented as XXPPØ1Ø. To find this pattern, the M-bits are loaded into a shift register (U44 and U45). Then a series of gates decode the pattern and synchronize to a counter (U46) which is dividing the M-bit clock by seven. If the counter pulse matches with two successive occurrences of the XXPPØ1Ø pattern, a signal is generated to declare the "M-Frame In-Sync" to the microprocessor.

Once the M-Frame pattern is declared "In-Sync", if two out of three detected sequences do not agree with the counter, a signal is generated to declare "M-Frame Out-of-Sync". Parity is calculated by toggling a flip-flop

(U49A) with each data "1" and comparing the results with the Parity bits (or the P-bits in the M-Frame sequence) when M1 occurs.

Incoming data is loaded into 4-bit shift registers U44 and U45 using the M-Clock signal as the shift register clock. Component U48B tests for matching X-bits from U45, pins 2 and 15, while U48A tests for matching P-bits from U45, pins 13 and 14. A wired-NAND condition is formed by U47A, U44 pins 14 and 2, U47 pin 9, and U48 pin 10. These outputs are all low only when both X bits are the same, both parity bits are the same, and the 010 pattern is present. This indicates a valid M-Frame, a low NAND condition produces a "1" at U47 pin 3. This condition will be held for one M-bit (or 680 clock cycles).

When the signal comparisons permit U47B to switch to a logic "1", this signal is inverted by U52A and applied as an input to the four-stage shift register, U66. The same logic "1" is also gated with the "Out-of-Sync" line at U51D and gated again by U53A with the terminal count of the Divide-by-Seven Counter (U46). The resulting signal is used to synchronize U46 to the XXPPØ1Ø pattern.

The terminal count signal (U46, pin 4) is also gated through U51A with the incoming F1 Bit Clock signal to clock the shift register U66. When the signal patterns synchronize, the shift register, U66, loads with "0's". Component U52B detects two successive matches and switches flip-flop U54A to indicate "In-Frame" which disables U51D from further synchronizing U46. If two of three bits loaded into U66 are "1's", the out-of-sync pattern is detected by U51B, and U51C which will cause reset to "Out-of-Sync" condition.

Input data signals are also inverted by U43C and applied to a J-K flip-flop (U49) which toggles with each Data "1" bit. The J-K flip-flop U65A is timed by the M-1 clock and stores the state of U49 from the last parity or superframe cycle. The saved state signal of U65A is exclusive ORed by U31C. If U31C pin 12 is a logic "1" at the M-1 clock pulse, then U49A and U65A outputs are in the same state indicating U49A toggled an even number of times since the last M-1 pulse. Conversely, if U31C, pin 12, is a logic "0", then U49A has toggled an odd number of times and U65A must toggle for an odd number of "1's" to equal the same state as U49A at the M-1 clock.

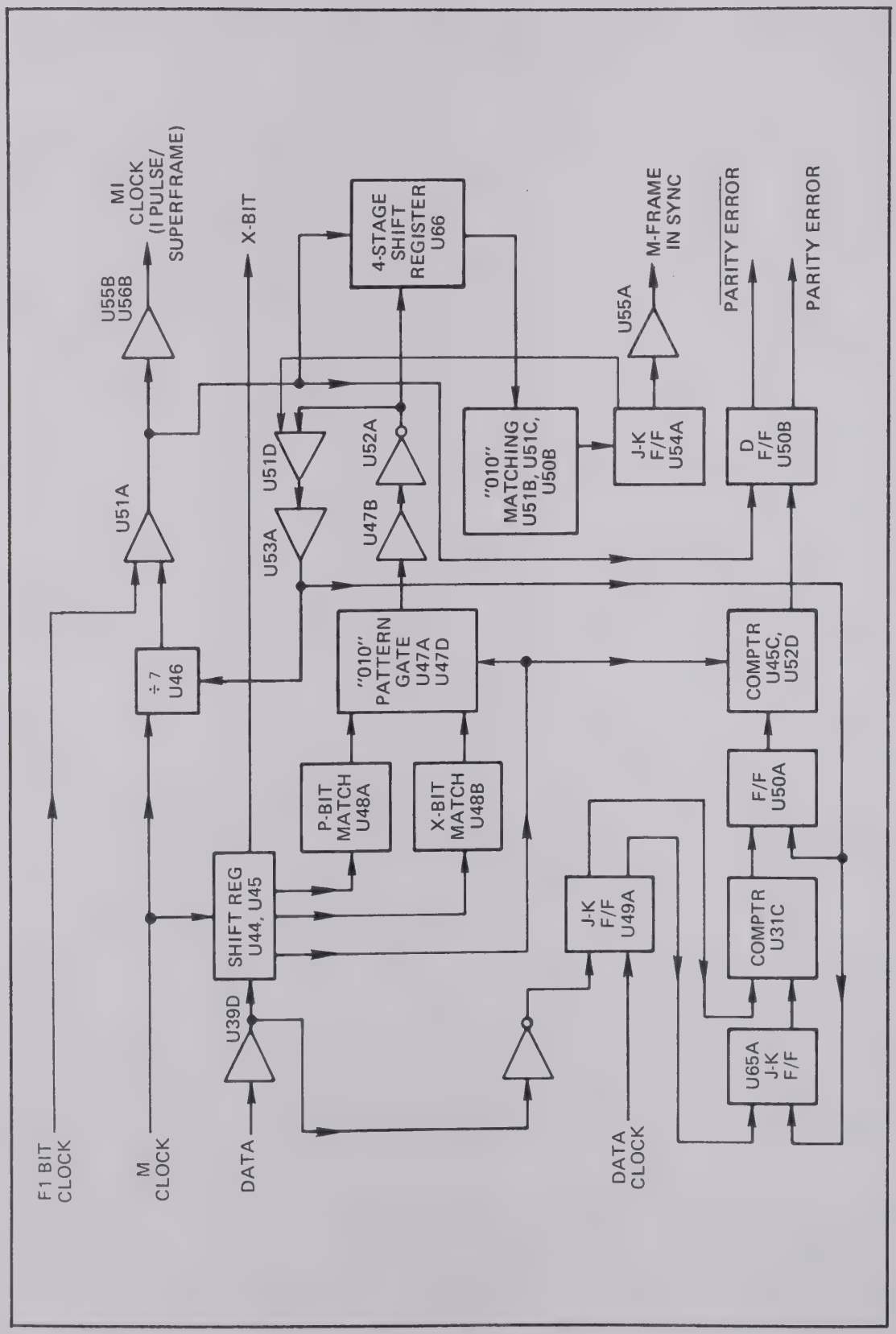


Figure 4.9. Model 4657B M-Frame Synchronizer Section, ECL Logic PWB (A2), Block Diagram

Flip-flop U50A stores the output of U31C. The state of U50A, pin 3, indicates whether an odd or even number of "1's" was contained in the last superframe. This signal is compared with both parity bits by U48C and U52D and the resulting signal is input into the D flip-flop, U50B, which is latched to the state of the parity test. The M-1 clock resets U50B so that successive parity bit error will cause separate parity error output pulses from U50B.

4.3.3.4 Pseudo Random Bit Generator Section

A block diagram of the Pseudo Random Bit Generator Section is shown in Figure 4.10. Circuits on this PWB generate a 32,767-bit sequence and synchronize it with a matching input sequence. Then a bit-by-bit comparison is performed to make bit error measurements. There is also an auxiliary circuit that determines the out-of-synchronization condition and causes the proper re-load of the sequence generator to resynchronize it to present signal conditions.

Components U16, U17, U18, and U19 are each a four-bit shift register and are cascaded to form a 15-bit shift register (the 16th stage is not used). This shift register is timed by the Gapped (or Data) Clock and the data input is either normal data or feedback data (register stages 14 and 15; U19, pins 15 and 12) through exclusive OR gate U11B. The circuit synchronizes the internally generated data sequence from U11B (U11, pin 10) with incoming data by loading the shift register with 15 bits of incoming data, then switching the shift register to "feedback" data through U11B.

The flip-flop component U13A selects between the Run or Load conditions. During the Load Mode, the 16-bit Counter (U12) is enabled to count 15 data clock cycles, while flip-flop U13A directs input data selection be made from the Shift Register through gate U24A. The Counter (U12) reaches terminal count after 15 data bits and resets flip-flop U13A which disables U12 and directs input data selection to the shift Register through U24B (or feedback data). If the incoming data signal was produced by a similar matching sequence generator, the input data will match, bit-for-bit, with the feedback data through U11B.

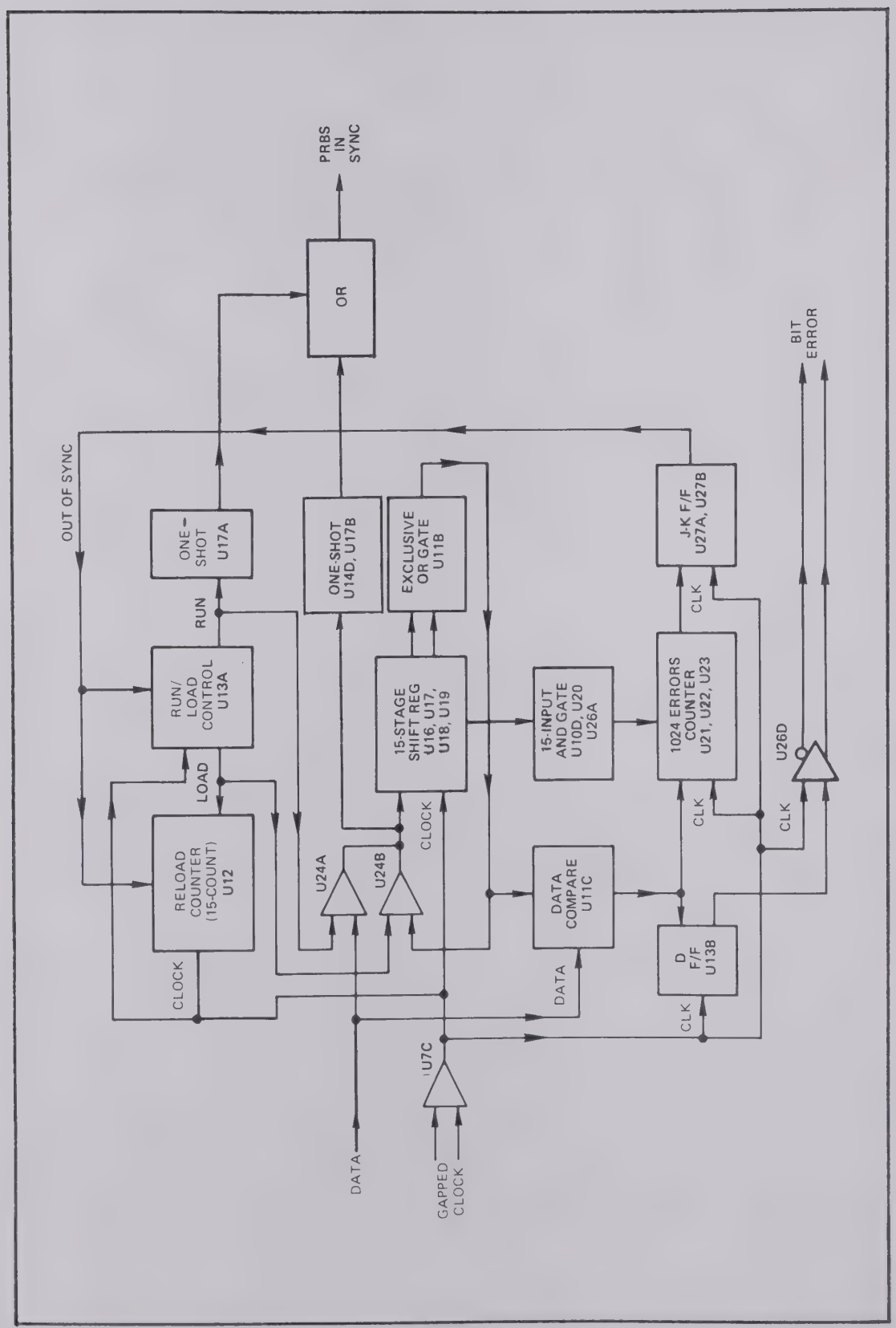


Figure 4.10. Model 4657B, Pseudo Random Bit Sequence Generator Section, ECL Logic PWB (A2), Block Diagram

Component U11C also performs a bit-by-bit comparison with the output (U11C, pin 12) being a logic "0" for each mismatch. A mismatch becomes an enable input to the 1024 Error Counter chain (components U21, U22, and U23), and to the input of Bit Error flip-flop U13B. The "Q" output of the Bit Error flip-flop (U13B, pin 15) is internally gated by the Gapped Clock signal to produce an output error pulse for each data bit error. Each data bit error also causes the counter chain to increment. If 1024 errors occur before 32,767 bits are totaled, the counter output (U23, pin 2) switches high. This signal causes flip-flops U27A and U27B to generate a pulse that will: (1) set U13A to the Load Mode, (2) cause the shift register components to re-load, and (3) fire the One Shot (U15A). The One Shot output signal is returned to the analyzer microprocessor circuits. When the incoming data presents compatible pseudo random bit sequences, the U15 output remains low indicating the In-Sync condition. If U15A is triggered, the output goes high and the microprocessor signals the condition by flashing the front panel PRBS indicator.

Monostable, U15B, is used to monitor the type of data in the shift register. If the data is all ones or all zeros (i.e. does not change within the time constant of the monostable) then the monostable will time out and force a PRBS loss indication to the microprocessor.

Components U10, U20, and U26A are used to detect 15 consecutive "1's". The "ALL 1's" condition will occur once per 32,767 bits and cause an output pulse from this circuit. This pulse will reset the 1024 Error Counter circuits and require another sequence of 1024 errors per 32,767 bits to reload the shift register.

4.3.3.5 Million Bit Interrupt Section

A block diagram of the Million bit interrupt section is shown in Figure 4.11. The million bit interrupt section counts system clock cycles and produces an interrupt to the microprocessor every 1 million clock cycles. These interrupts are used to latch the error counters data and signal the processor to read the counters and calculate the error rates.

U59 and U60 are high speed decode counters which each divide by 10. U61A, U61B, U62A, and U62B also each divide by 10 for a total division of 1 million. When one million bits have been counted, flip-flops U63A and U63B produce an output one system clock cycle wide. This million bit strobe is used to latch the error counters data and produce an interrupt to the microprocessor.

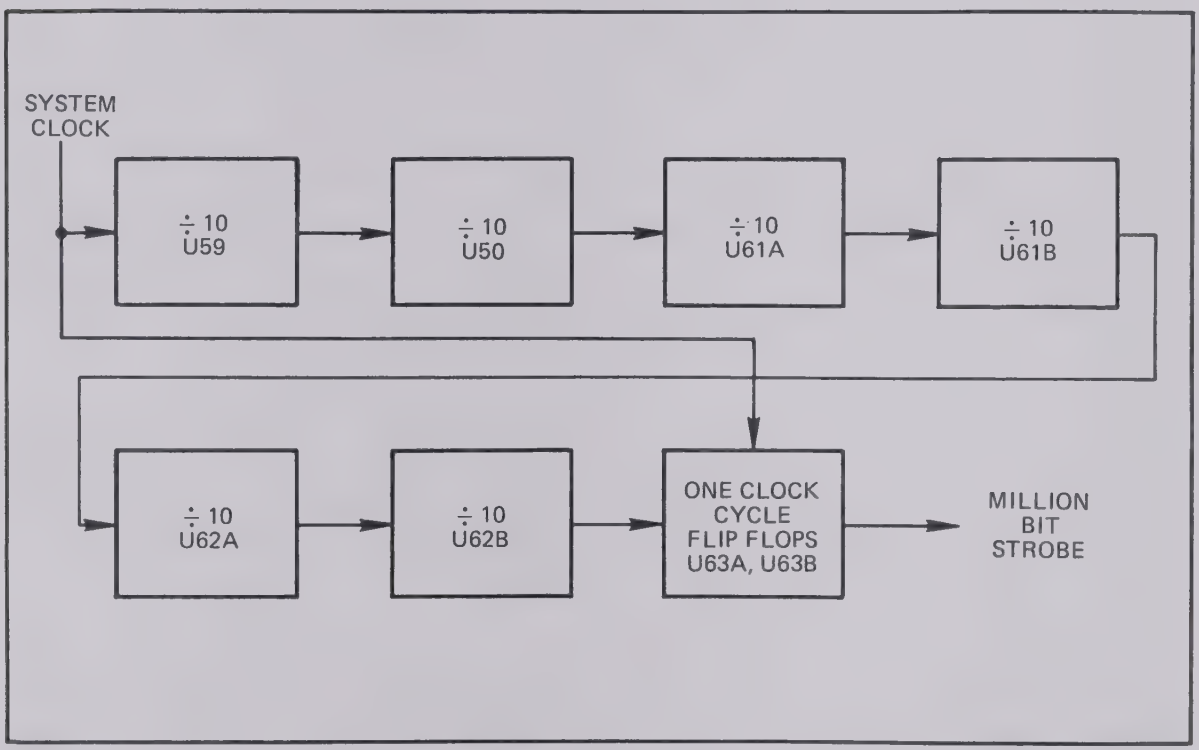


Figure 4.11. Model 4657B Million Bit Interrupt Section, ECL Logic PWB (A2), Block Diagram

4.3.4 Processor PWB (A1)

A block diagram of the Model 4657B Processor PWB (A1) is shown in Figure 4.12. The schematic is shown in Figure 7.3.

4.3.4.1 CPU and Memory Circuitry

The microprocessor circuitry consists of three integrated circuits: the 8080 Microprocessor, the 8224 clock generator, and the 8228 system controller. On-board decoders select appropriate RAM, ROM, and I/O ports from the address bus and generate address, data, and control busses which are buffered and then output to the system bus.

The on-board ROM memory consists of up to five 2764 EPROMS which provide 40K bytes. The on-board RAM memory consists of up to three 6116 CMOS RAM to provide 6K bytes. On-board memory address decoding is done to the 8K address block level. See Figure 4.12.

Model 4657B Processor Printed Wiring Board Specifications. Specifications applicable to the Processor printed wiring board are as follows:

Microprocessor

8080 Integrated Circuit (IC) using an 8224 IC Clock Generator and an 8238 (or 8228) IC System Controller. The Clock frequency is 18.432 MHz and the arrangement provides one interrupt.

Memory

ROM (Read Only Memory) using five 2764 IC's (JEDEC standard pinout) for a total of 40K bytes.
RAM (Random Access Memory) using three 6116 IC for 6K Bytes (static RAM).

Power Requirements

+12V dc at 0.15 Amp (Max)
+5.0V dc at 2.5 Amp (Max)
-5.0V dc at 0.05 Amp (Max)
-12V dc at 0.15 Amp (Max)

Input/Output (I/O)

One 8255A IC providing 24 lines of programmable I/O and is used to drive the Model 4650 local printer option.

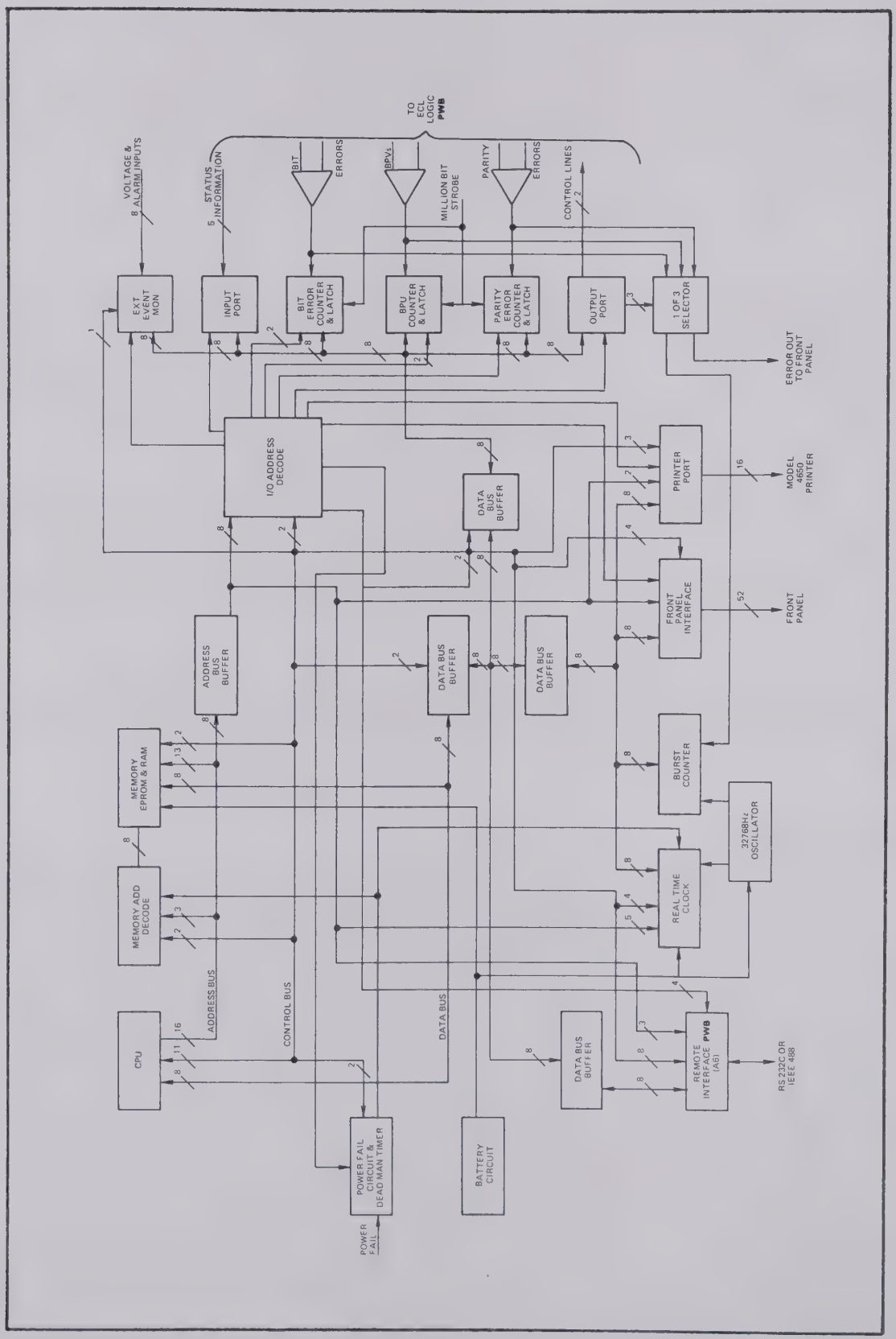


Figure 4.12. Model 4657B Processor PWB (A1), Block Diagram

Memory Map. The memory map for the Model 4657B Analyzer is shown in Figure 4.13. The Model 4657B CPU circuit resets to address Ø, and ROM is addressed starting at Ø.

Input/Output (I/O) Map. A complete I/O assignment map for the Model 4657B Processor printed wiring board is shown in Table 4.1.

Microprocessor Component Group. The standard three chip configuration of the 8080 Microprocessor consists of the 8080 IC (U1), an 8238 (or 8228) IC (U2) System Controller, and an 8224 IC (U3) Clock Generator. These three IC's are interconnected in the manufacturer's recommended configurations and operate as the "brains" of the printed wiring board.

The Clock Generator (U3) produces the different timing signals necessary for operation of the 8080 Microprocessor (U1) based on the frequency of the crystal, Y1. The recommended crystal frequency of 18.432 MHz generates $\phi 1$ and $\phi 2$ frequencies at 2.048 MHz to cycle the 8080 Microprocessor circuits in 488 nanoseconds. The $\phi 2$ TTL Clock signal is output at 2.048 MHz, which is easily divided down to standard reference frequencies for the Serial I/O Port and other uses.

The remaining signals in the Address Bus, the Data Bus, and the Control Bus will be described as they are used with other circuits.

Address Bus Buffers and Decoders. U4 buffers the lower byte of the address bus onto the system bus for use by the I/O port decoders.

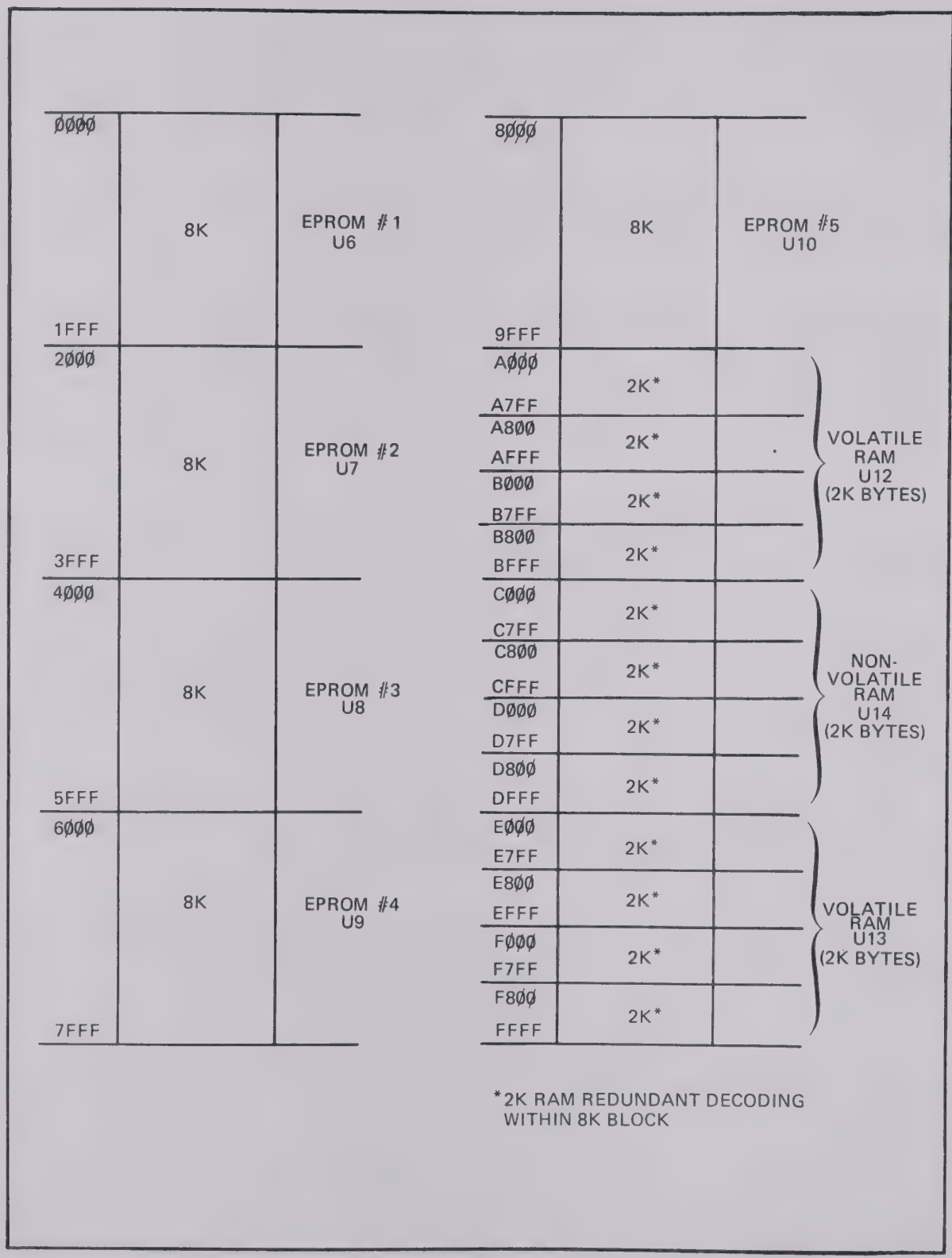


Figure 4.13. Model 4657B Processor PWB (A1), Memory Map

Table 4.1
Model 4657B Analyzer,
Operational Program I/O Assignments

Port Hardware	Instruction	Address	Operation
BIT Error Counter (E.C.1) and External Event Monitor	Input	EØ-E3H	Input low order 8-bits of Bit Error Counter and clear 10^6 Interrupt
	Input	E4-E7H	Input both high order 4-bits of Bit Error Counter and Million-Bit Interrupt Status.
	Input	E8-EBH	Resets Digit Counter U78
	Input	EC-EFH	Increments Digit Counter U78
	Input	FØ-F3H	Input data byte from ADC latch U82
	Input	F4-F7H	Input strobe status bit from U81
Real-Time Clock	Input/Output	ØØH	Milliseconds counter, BCD (Top 4 bits)
	Input/Output	Ø1H	Tenths and Hundredths of Seconds, BCD
	Input/Output	Ø2H	Seconds, BCD
	Input/Output	Ø3H	Minutes, BCD
	Input/Output	Ø4H	Hours, BCD
	Input/Output	Ø5H	Day of the Week, BCD
	Input/Output	Ø6H	Day of the Month, BCD
	Input/Output	Ø7H	Months, BCD
	Output	Ø8H	Milliseconds comparison latch
	Output	Ø9H	Tenths and hundredths of seconds comparison latch
	Output	ØAH	Seconds comparison latch
	Output	ØBH	Minutes comparison latch
	Output	ØCH	Hours comparison latch
	Output	ØDH	Day of the week comparison latch
	Output	ØEH	Day of the month comparison latch
	Output	ØFH	Months comparison latch
	Input	1ØH	Interrupt Status
	Output	11H	Interrupt Control
	Output	12H	Counter Reset
	Output	13H	Latch Reset
	Input	14H	Status Bit
	Output	15H	"GO" command
	Output	16H	Standby Interrupt
	Output	1FH	Test mode

Table 4.1. - continued

Port Hardware	Instruction	Address	Operation
Burst Counter	Input	2Ø-27H	Input number of bursts and poll Real-Time Clock Interrupt.
	Input	28-2FH	Length of Burst
	Input/Output	3Ø-37H	Reset burst counter interrupt
Dead-Man Timer	Input/Output	38-3FH	Reset Dead-Man Timer
Front Panel I/O	Input/Output	4Ø-43H	8279 Data, Read Switch Address or Write Display
	Input/Output	44-47H	8279 Data, Control Register
	Output	48-4FH	Octal Latch U16: controls discrete LEDs.
	Output	5Ø-57H	Octal Latch U17: controls discrete LEDs.
BPV and Parity Error Counters	Input	CØ-C7H	Read low order 8-bits of Bipolar Violation Counter
	Input	C8-CFH	Read high order 4-bits of Bipolar Violation Counter and Error Seconds Selector.
	Input	DØ-D7H	Read 8-bits of Parity Error
Status Port	Input	D8-DFH	Read STATUS Lines: SIGNAL LOSS, FRAME LOSS, BLUE SIGNAL, PRBS LOSS.
Control Port	Output	D8-DFH	Output to Select Error Output for front panel connector. Select DSX-3 Compensation, and framing enable/disable.
RS-232 Interface	Input/Output	8Ø-83H	8251A USART; DATA
	Input/Output	84-87H	8251A USART; COMMAND/STATUS
	Input/Output	88-89H	8253: COUNTER Ø
	Input/Output	8A-8BH	8253: COUNTER 1
	Input/Output	8C-8DH	8253: COUNTER 2
	Input/Output	8E-8FH	8253: COMMAND/STATUS
	Input/Output	9Ø-97H	Increment Counter 2
	Input/Output	98-9FH	Baud Rate (Bits 5, 6, 7 = Baud, Ø-4 unused)
IEEE-488 Interface	Input/Output	AØH	Interrupt Status and Mask
	Input/Output	A1H	Command Status Register
	Input/Output	A2H	Address Mode
	Input/Output	A3H	Auxiliary Command
	Input/Output	A4H	Address Register
	Input/Output	A5H	Serial Poll Register
	Input/Output	A6H	Parallel Poll Register
	Input/Output	A7H	Data Register

Table 4.1. - continued

Hardware	Instruction	Port Address	Operation
Printer I/O	Input/Output	6Ø67H	8255A: Port A
	Input/Output	68-6FH	8255A: Port B
Printer I/O	Input/Output	7Ø-77H	8255A: Port C
	Input/Output	78-7FH	CONTROL REGISTER
Miscellaneous	----	58-5FH	Unused
		F8-FBH	Unused
		FC-FFH	For test purposes

Data Bus Buffers. U16 (74LS245) provides bidirectional data bus buffering between the memory data bus (DBØ-DB7) and the system data bus (BDBØ-BDB7). Data flows in or out with the buffer direction controlled by U15B. The Data Bus Buffer (U16) always outputs data onto the bus except during Input/Output Read (IOR). U16 is enabled by either I/O Read or I/O Write going low.

Three other 74LS245s (U17, U68, and U91) buffer the system data bus to the various I/O ports. U17 buffers the system data bus to the peripheral data bus (PDØ-PD7) for the Real-Time Clock (U27), the burst counters U29, U35, the front panel interfaces (U39, U50, U52) and the local printer interface (U36). U17 is enabled whenever an I/O operation occurs in the address range ØØ to 7F.

U68 buffers the system data bus to the Error Counter data bus (EDØ-ED7). The error counter data bus connects to the three error counters (U65, U66, U67, U85 and U87), the control output port (U69), the status input port (U72), the External Event Monitor port (U82) and the million bit interrupt latch (U88). U68 is enabled whenever an I/O operation occurs in the address range CØ to FF.

U91 buffers the system data bus to the remote interface boards (RDØ-RD7). U91 is enabled, whenever an I/O operation occurs in the address range 8Ø to BF.

Random Access Read/Write Memory (RAM). The RAM consists of three 6116 CMOS static RAMs (2K x 8 ea.), providing 6144 bytes of usable memory (U12 may not be installed). Eleven lines of the address bus connect to the RAM address to select a particular location and chip select for memory control of data transfer between the CPU and the RAM. The Memory Write (MEMW), which is output from the 8228 chip (U2), is low during memory write instructions and high at all other times.

The Memory Write function strobes data bus data into the RAM when low and puts RAM data onto the data bus when high. The RAM select is decoded by U11. U20A and B are used to disable the N.V. RAM after power-fail one-shot U18A times out to protect the data during a power failure. RAM addresses are shown in the Memory Map, Figure 4.13.

Read Only Memory (ROM). Five 28-pin sockets, designated U6 through U10, are provided for program storage using 2764 EPROMs. (U10 may not be installed.)

The address bus lines AØ through A12 are wired directly to the EPROMs. Chip select decoding is provided by U11. EPROM addresses are shown in the Memory Map, Figure 4.13. The ROM outputs are 3-state and whenever chip select is enabled, the contents of the addressed location are output onto the data bus.

Printer Interface - The optional Model 4650 local printer is controlled through U36, an 8255A Programmable Peripheral Interface. The 8255A is located at addresses 6Ø-7FH (see I/O Map, Table 4.1). Port B and Port C outputs are wired to connector J1, which extends through the rear panel of the unit. Port A is not used. The local printer is connected to J1 through which it receives power, data, and control signals. Port B supplies eight bits of data to the printer and port C supplies six control lines (see Section 4.4C - Option Model 4650: Dot Matrix Printer).

Miscellaneous Circuitry. The Ready input is used by the Real-Time clock and the Remote Interface. The signals Wait, Reset, Sync, ϕ2 clock, and Interrupt are buffered for use by other circuits on the board. Other control bus signals, such as IOR, IOW, MEMR, MEMW, etc. are wired directly to and from the 8080 Microprocessor circuits.

4.3.4.2 Real-Time Clock and Burst Counter Circuitry

The timebase for the real-time clock consists of a 32768 Hz crystal (Y2) (see Figure 4.14), a phase-shifting network (C7 and R3), a trimmer capacitor (C8), and a 4060 CMOS 14-stage binary counter (U28). U27, the Real-Time Clock, is interfaced to the microprocessor bus through the data bus buffer (U17) and address decoding circuitry (U24, and U15), and resides at port address ØØH through 1FH, except for 18, 19, 1A and 1B. Figure 4.15 (6 sheets) is a data sheet on this device, the MM58167A.

The Error Burst measurement process is fairly complex and is mostly contained in U28, U30, U31, U33, U34, and U35. First, a 1024 Hz (~ 1 millisecond) clock is acquired from the Real-Time Clock time base (U28). Q6 and U29B isolate the time base from the burst counter when power is off. Two D-flip-flops (U30A and U30B) serve as a burst detector; U30A is set every millisecond and remains set in the absence of errors. At the beginning of the next millisecond, this state is transferred to U30B, providing a record of whether the preceeding millisecond contained an error. Thus, U30B remains clear for the duration of an error burst. Inverter U32A allows U34 to count the duration of each burst up to a maximum of 125 milliseconds. At the end of an error burst, the rising edge on pin 9 of U30B, increments the burst counter (U31) and sets the burst interrupt flip-flop (U33A). If this was the first burst since the interrupt was last serviced, the burst length is transferred to the output latch U35. The burst interrupt is reset by writing to any port address in the range 3ØH to 37H. The number of bursts counter is read in the bottom 3 bits of any port 20H through 27H. The length of burst is read from any port 28H through 2FH.

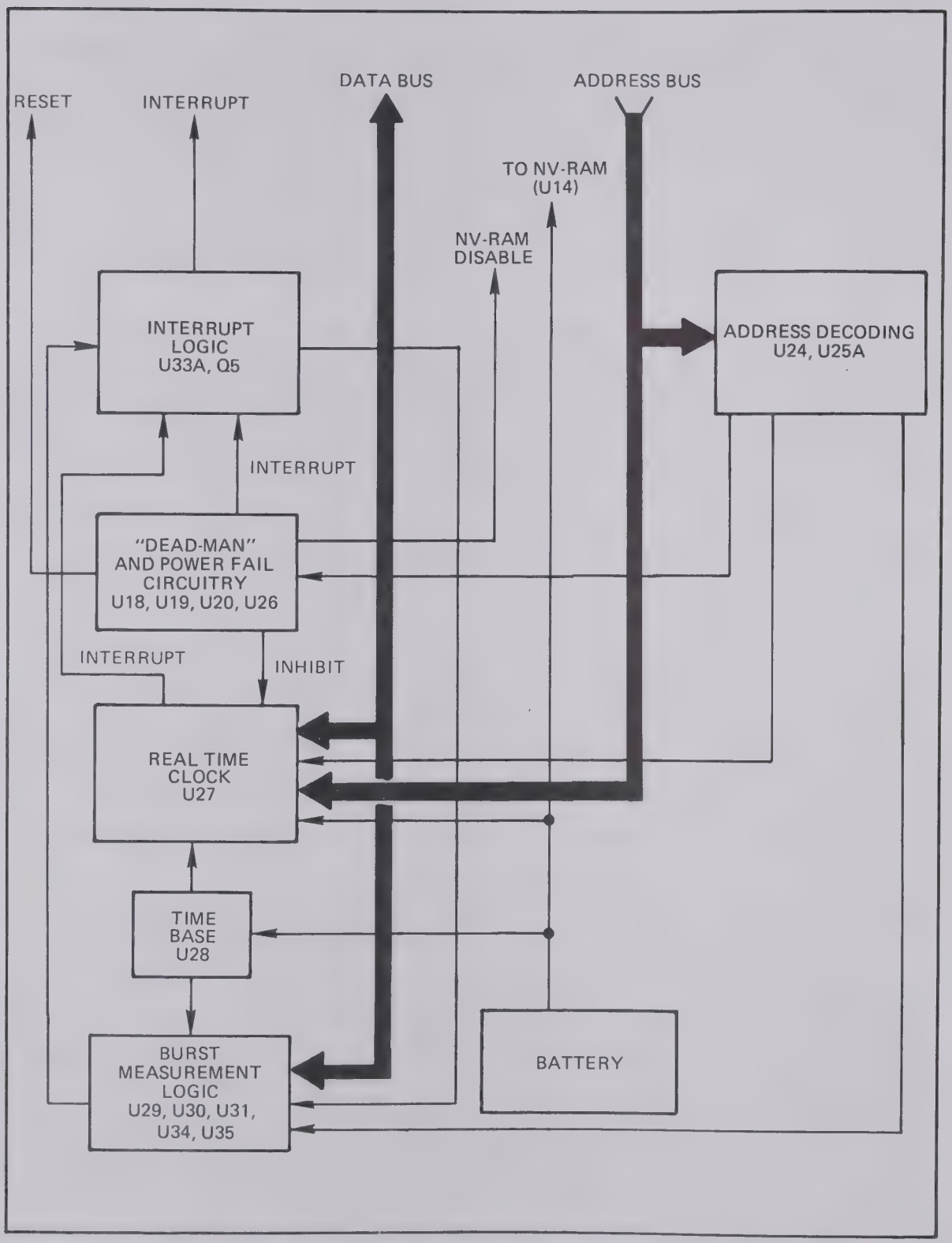


Figure 4.14. Model 4657B, Real-Time Clock Burst Counter, Power Fail, and Dead-Man Timer Circuitry, Block Diagram

National Semiconductor

April 1982

MM58167A Microprocessor Real Time Clock

General Description

The MM58167A is a low threshold metal gate CMOS circuit that functions as a real time clock in bus oriented microprocessor systems. The device includes an addressable real time counter, 56 bits of RAM, and two interrupt outputs. A $\overline{\text{POWER DOWN}}$ input allows the chip to be disabled from the rest of the system for standby low power operation. The time base is a 32,768 Hz crystal oscillator.

Features

- Microprocessor compatible (8-bit data bus)
- 1/10,000 of a second through month counters
- 56 bits of RAM with comparator to compare the real time counter to the RAM data
- 2 INTERRUPT OUTPUTS with 8 possible interrupt signals
- $\overline{\text{POWER DOWN}}$ input that disables all inputs and outputs except for one of the interrupts
- Status bit to indicate rollover during a read
- 32,768 Hz crystal oscillator
- Four-year calendar (no leap year)
- 24-hour clock

Functional Description

Real Time Counter

The real time counter is divided into 4-bit digits with 2 digits being accessed during any read or write cycle. Each digit represents a BCD number and is defined in Table I. Any unused bits are held at a logical zero during a read and ignored during a write. An unused bit is any bit not necessary to provide a full BCD number. For example tens of hours cannot legally exceed the number 2, thus only 2 bits are necessary to define the tens of hours. The other 2 bits in the tens of hours digit are unused. The unused bits are designated in Table I as dashes.

The addressable portion of the counter is from 1/10,000 of a second to months. The counter itself is a ripple counter. The ripple delay is less than 60 μs above 4.0V and 300 μs at 2.0V.

RAM

56 bits of RAM are contained on-chip. These can be used for any necessary power down storage or as an alarm latch for comparison to the real time counter. The data in the RAM can be compared to the real time counter on a digit basis. The only digits that are not compared are the unit ten thousandths of seconds and tens of days of the week (these are unused in the real time counter). If the two most significant bits of any RAM digit are ones, then this RAM location will always compare.

The RAM is formatted the same as the real time counter, 4 bits per digit, 14 digits, however there are no unused bits. The unused bits in the real time counter will compare only to zeros in the RAM

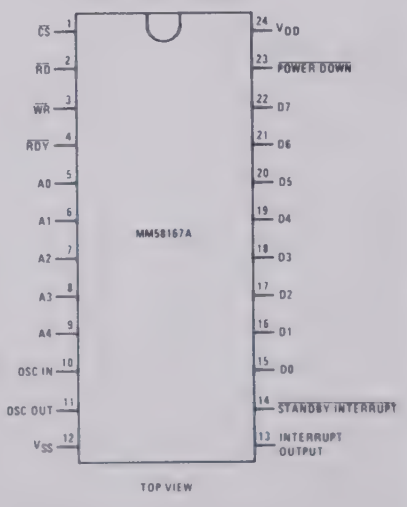
Interrupts and Comparator

There are two interrupt outputs. The first and most flexible is the INTERRUPT OUTPUT (a true high signal). This output can be programmed to provide 8 different output signals. They are: 10 Hz, 1 Hz, once per minute, once per hour, once a day, once a week, once a month, and when a RAM/real time counter comparison occurs. To enable the output a one is written into the interrupt control register at the bit location corresponding to the desired output frequency *(Figure 1)*. Once one or more bits have been set in the interrupt control register, the corresponding counter's rollover to its reset state will clock the interrupt status register and cause the interrupt output to go high. To reset the interrupt and to identify which frequency caused the interrupt, the interrupt status register is read. Reading this register places the contents of the status register on the data bus. The interrupting frequency will be identified by a one in the respective bit position. Removing the read will reset the interrupt.

The second interrupt is the $\overline{\text{STANDBY INTERRUPT}}$ (open drain output, active low). This interrupt occurs when enabled and when a RAM/real time counter comparison occurs. The $\overline{\text{STANDBY INTERRUPT}}$ is enabled by writing a one on the D0 line at address 16_H or disabled by writing a zero on the D0 line. This interrupt is not triggered by the edge of the compare signal, but rather by the level. Thus if the compare is enabled when the $\overline{\text{STANDBY INTERRUPT}}$ is enabled, the interrupt will turn on immediately.

Connection Diagram

Dual-In-Line Package



TOP VIEW

1982 National Semiconductor Corp BB-2027

IM B25M42/Printed in U.S.A.

Courtesy of National Semiconductor Corp.

Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 1 of 8)

Absolute Maximum Ratings

Voltage at All Pins	$V_{SS}-0.3V$ to $V_{DD}+0.3V$
Operating Temperature	$-40°C$ to $85°C$
Storage Temperature	$-65°C$ to $150°C$
$V_{DD}-V_{SS}$	6.0V
Lead Temperature (Soldering, 10 seconds)	300°C

Electrical Characteristics $V_{SS}=0V$, $-40°C \le T_A \le 85°C$

Parameter	Conditions	Min	Max	Units
Supply Voltage				
V_{DD}	Outputs Enabled	4.0	5.5	V
V_{DD}	$\overline{\text{POWER DOWN}}$ Mode	2.0	5.5	V
Supply Current				
I_{DD}, Static	Outputs TRI-STATE*			
	$f_{IN}=DC$, $V_{DD}=5.5V$		10	μA
I_{DD}, Dynamic	Outputs TRI-STATE			
	$f_{IN}=32$ kHz, $V_{DD}=5.5V$			
	$V_{IH} \ge V_{DD}-0.3V$			
	$V_{IL} \le V_{SS}+0.3V$		20	μA
I_{DD}, Dynamic	Outputs TRI-STATE			
	$f_{IN}=32$ kHz, $V_{DD}=5.5V$			
	$V_{IH}=2.0V$, $V_{IL}=0.8V$		5	mA
Input Voltage				
Logical Low		0.0	0.8	V
Logical High		2.0	V_{DD}	V
Input Leakage Current	$V_{SS} \le V_{IN} \le V_{DD}$	-1	1	μA
Output Impedance	I/O and INTERRUPT OUT			
Logical Low	$V_{DD}=4.5V$, $I_{OL}=1.6$ mA		0.4	V
Logical High	$V_{DD}=4.5V$, $I_{OH}=-400\ \mu A$	2.4		V
	$I_{OH}=-10\ \mu A$	$0.8\ V_{DD}$		V
TRI-STATE	$V_{SS} \le V_{OUT} \le V_{DD}$	-1	1	μA
Output Impedance	$\overline{\text{RDY}}$ and $\overline{\text{STANDBY}}$ $\overline{\text{INTERRUPT}}$			
Logical Low, Sink	$V_{DD}=4.5V$, $I_{OL}=1.6$ mA		0.4	V
Logical High, Leakage	$V_{OUT} \le V_{DD}$		10	μA

Functional Description (Continued)

TABLE I. REAL TIME COUNTER FORMAT

Counter Addressed		Units D0	D1	D2	D3	Max BCD Code	Tens D4	D5	D6	D7	Max BCD Code
1/10,000 of Seconds	(00_H)	-	-	-	-	0	D4	D5	D6	D7	9
Hundredths and Tenths Sec	(01_H)	D0	D1	D2	D3	9	D4	D5	D6	D7	9
Seconds	(02_H)	D0	D1	D2	D3	9	D4	D5	D6	-	5
Minutes	(03_H)	D0	D1	D2	D3	9	D4	D5	D6	-	5
Hours	(04_H)	D0	D1	D2	D3	9	D4	D5	-	-	2
Day of the Week	(05_H)	D0	D1	D2	-	7	-	-	-	-	0
Day of the Month	(06_H)	D0	D1	D2	D3	9	D4	D5	-	-	3
Month	(07_H)	D0	D1	D2	D3	9	D4	-	-	-	1

(-) indicates unused bits

TRI-STATE® is a registered trademark of National Semiconductor Corp

Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 2 of 8)

Functional Description (Continued)

TABLE II. ADDRESS CODES AND FUNCTIONS

A4	A3	A2	A1	A0	Function
0	0	0	0	0	Counter—Ten Thousandths of Seconds
0	0	0	0	1	Counter—Hundredths and Tenths of Seconds
0	0	0	1	0	Counter—Seconds
0	0	0	1	1	Counter—Minutes
0	0	1	0	0	Counter—Hours
0	0	1	0	1	Counter—Day of Week
0	0	1	1	0	Counter—Day of Month
0	0	1	1	1	Counter—Month
0	1	0	0	0	RAM—Ten Thousandths of Seconds
0	1	0	0	1	RAM—Hundredths and Tenths of Seconds
0	1	0	1	0	RAM—Seconds
0	1	0	1	1	RAM—Minutes
0	1	1	0	0	RAM—Hours
0	1	1	0	1	RAM—Day of Week
0	1	1	1	0	RAM—Day of Month
0	1	1	1	1	RAM—Months
1	0	0	0	0	Interrupt Status Register
1	0	0	0	1	Interrupt Control Register
1	0	0	1	0	Counters Reset
1	0	0	1	1	RAM Reset
1	0	1	0	0	Status Bit
1	0	1	0	1	GO Command
1	0	1	1	0	$\overline{\text{STANDBY}}$ $\overline{\text{INTERRUPT}}$
1	1	1	1	1	Test Mode

All others unused

Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 3 of 8)

Functional Description (Continued)

The comparator is a cascaded exclusive NOR. Its output is latched 61 μs after the rising edge of the 1 kHz clock signal (input to the ten thousandths of seconds counter). This allows the counter to ripple through before looking at the comparator. For operation at less than 4.0V, the thousandths of seconds counter should not be included in a compare because of the possibility of having a ripple delay greater than 61 μs. (For output timing see Interrupt Timing.)

Power Down Mode

The $\overline{\text{POWER DOWN}}$ input is essentially a second chip select. It disables all inputs and outputs except for the $\overline{\text{STANDBY INTERRUPT}}$. When this input is at a logical zero, the device will not respond to any external signals. It will, however, maintain timekeeping and turn on the $\overline{\text{STANDBY INTERRUPT}}$ if programmed to do so. (The programming must be done before the $\overline{\text{POWER DOWN}}$ input goes to a logical zero.) When switching V_{DD} to the standby or power down mode, the $\overline{\text{POWER DOWN}}$ input should go to a logical zero at least 1 μs before V_{DD} is switched. When switching V_{DD} all other inputs must remain between $V_{SS} - 0.3V$ and $V_{DD} + 0.3V$. When restoring V_{DD} to the normal operating mode, it is necessary to insure that all other inputs are at valid levels before switching the $\overline{\text{POWER DOWN}}$ input back to a logical one. These precautions are necessary to insure that no data is lost or altered when changing to or from the power down mode.

Counter and RAM Resets; GO Command

The counters and RAM can be reset by writing all 1's (FF) at address 12_H or 13_H respectively.

A write pulse at address 15_H will reset the thousandths, hundredths, tenths, units, and tens of seconds counters. This GO command is used for precise starting of the clock. The data on the data bus is ignored during the write. If the seconds counter is at a value greater than 40 when the GO is issued, the minute counter will increment; otherwise the minute counter is unaffected. This command is not necessary to start the clock, but merely a convenient way to start precisely at a given minute. (See Table III for reset format.)

Status Bit

The status bit is provided to inform the user that the clock is in the process of rolling over when a counter is read. The 1 kHz clock into the thousandths of seconds counter has a pulse width of 61 μs. If a read of the real time counter (any digits) is done during this 61 μs period the status bit will be set. This tells the user that the clock is rippling through the real time counter. Because the clock is rippling, invalid data may be read from the counter. If the status bit is set following a counter read, the counter should be reread.

The status bit appears on D0 when address 14_H is read. All the other data lines will be zero. The bit is set when a logical one appears. This bit should be read every time a counter read or series of counter reads are done. The trailing edge of the read at address 14_H will reset the status bit.

Oscillator

The oscillator used is the standard Pierce oscillator. Externally only 2 capacitors and the crystal are required. For micropower crystals a resistor in series with the oscillator output may be necessary to insure the crystal is not overdriven. This resistor should be approximately 200 kΩ. The capacitor values should be typically 20 pF-25 pF. The crystal frequency is 32,768 Hz.

The oscillator input can be externally driven, if desired. In this case the output should be left floating and the input levels should be within 0.3V of the supplies.

A ground line or ground plane between pins 9 and 10 may be necessary to prevent interference of the oscillator by the A4 address.

Control Lines

The $\overline{\text{READ}}$, $\overline{\text{WRITE}}$, and $\overline{\text{CHIP SELECT}}$ signals are active low inputs. The $\overline{\text{READY}}$ signal is an open drain output. At the start of each read or write cycle the $\overline{\text{READY}}$ line (open drain) will pull low and will remain low until valid data from a chip read appears on the bus or data on the bus is latched in during a write. $\overline{\text{READ}}$ and $\overline{\text{WRITE}}$ must be accompanied by a $\overline{\text{CHIP SELECT}}$ (see *Figures 3 and 4* for read and write cycle timing).

Test Mode

The test mode is merely a mode for production testing. It allows the counters to count at a higher than normal rate. In this mode the 32 kHz oscillator input is connected directly to the ten thousandths of seconds counter. The chip select and write lines must be low and the address must be held at IF_H.

Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 4 of 8)

Functional Description (Continued)

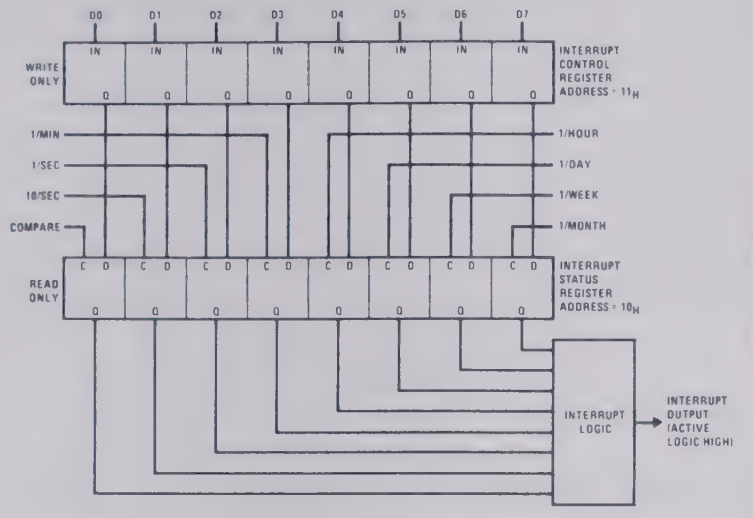


FIGURE 1. Interrupt Register Format

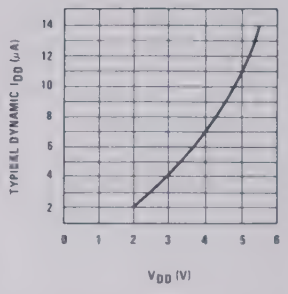


FIGURE 2. Typical Supply Current vs Supply Voltage

Interrupt Timing $-40°C \le T_A \le 85°C$, $4.5V \le V_{DD} \le 5.5V$, $V_{SS} = 0V$

Parameter		Min	Max	Units
t_{INTON}	Status Register Clock to INTERRUPT OUTPUT (Pin 13) High (Note 1)		5	μs
t_{SBYON}	Compare Valid to $\overline{\text{STANDBY INTERRUPT}}$ (Pin 14) Low (Note 1)		5	μs
t_{INTOFF}	Trailing Edge of Status Register Read to INTERRUPT OUTPUT Low		5	μs
t_{SBYOFF}	Trailing Edge of Write Cycle (D0 = 0; Address = 16_H) to $\overline{\text{STANDBY INTERRUPT}}$ Off (High Impedance State)		5	μs

Note 1: The status register clocks are the corresponding counter's rollover to its reset state or the compare becoming valid. The compare becomes valid 61 μs after the 1/10,000 of a second counter is clocked, if the real time counter data matches the RAM data.

Read Cycle Timing $-40°C \le T_A \le 85°C$, $4.5V \le V_{DD} \le 5.5V$, $V_{SS} = 0V$

Parameter		Min	Max	Units
t_{AR}	Address Bus Valid to Read Strobe	100		ns
t_{CSR}	Chip Select to Read Strobe	0		ns
t_{RRY}	Read Strobe to Ready Strobe		150	ns
t_{RYD}	Ready Strobe to Data Valid		800	ns
t_{AD}	Address Bus Valid to Data Valid		1050	ns
t_{RH}	Data Hold Time From Trailing Edge of Read Strobe	0		ns
t_{HZ}	Trailing Edge of Read Strobe to TRI-STATE Mode		250	ns
t_{RYH}	Read Hold Time after Ready Strobe	0		ns
t_{HA}	Address Bus Hold Time from Trailing Edge of Read Strobe	50		ns

Note 2: If $t_{AR} = 0$ or $t_{DW} = 0$ and Chip Select, Address Valid, Read or Write are coincident then they must exist for 1050 ns.

Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 5 of 8)

Write Cycle Timing $-40°C \le T_A \le 85°C$, $4.5V \le V_{DD} \le 5.5V$, $V_{SS} = 0V$

Parameter		Min	Max	Units
t_{AW}	Address Valid to Write Strobe	100		ns
t_{CSW}	Chip Select to Write Strobe	0		ns
t_{DW}	Data Valid before Write Strobe	100		ns
t_{WRY}	Write Strobe to Ready Strobe		150	ns
t_{RY}	Ready Strobe Width		800	ns
t_{RYH}	Write Hold Time after Ready Strobe	0		ns
t_{WD}	Data Hold Time after Write Strobe	110		ns
t_{WA}	Address Hold Time after Write Strobe	50		ns

Data bus loading is 100 pF
Ready output loading is 50 pF and 20 kΩ pull-up
Input and output AC timing levels
Logical one = 2.0V
Logical zero = 0.8V

Read and Write Cycle Timing Diagrams

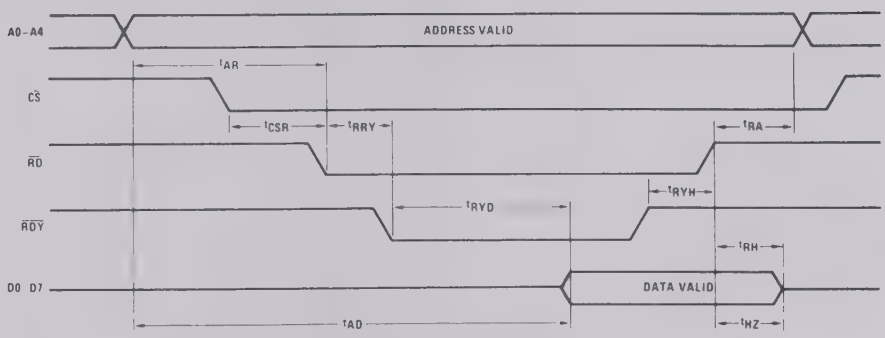


FIGURE 3. Read Cycle Timing

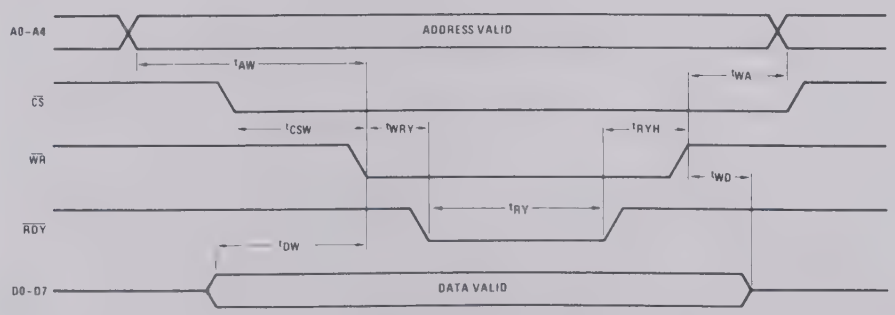
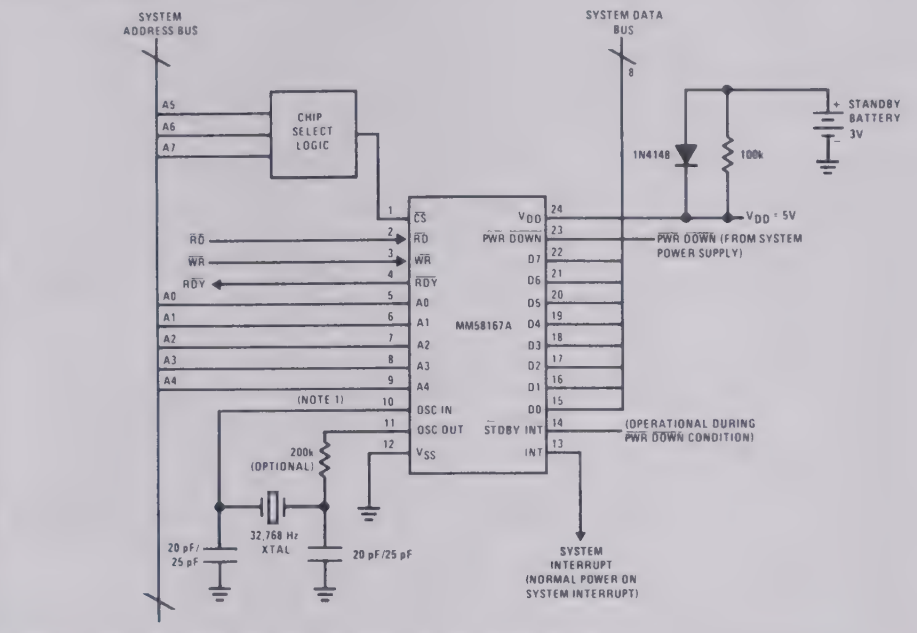


FIGURE 4. Write Cycle Timing

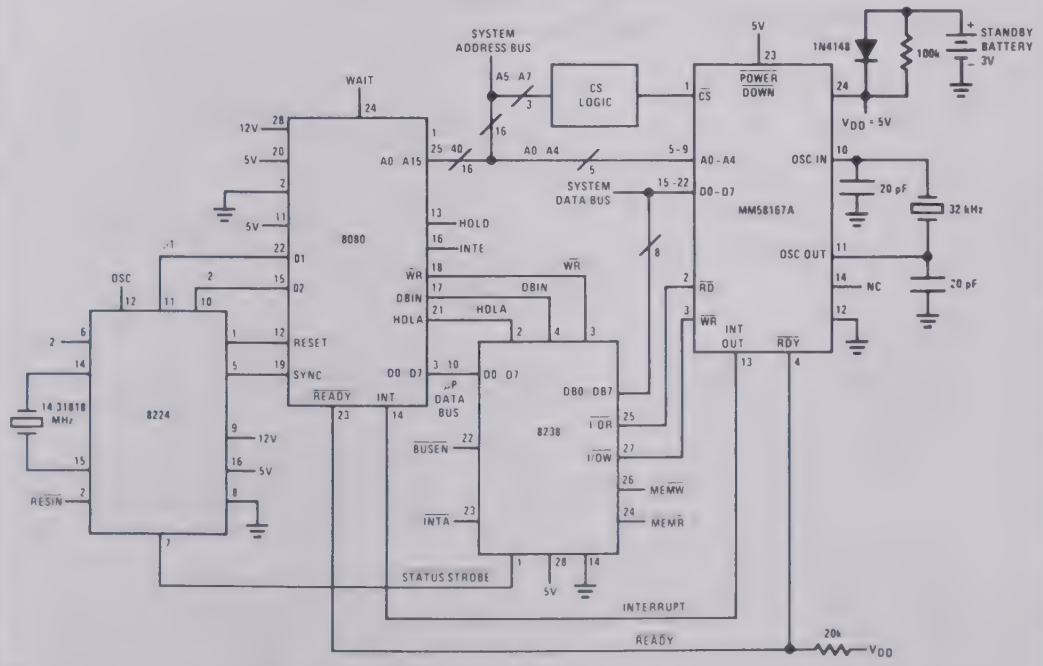
Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 6 of 8)

Typical Applications



Note 1: A ground line or ground plane guard trace should be included between pins 9 and 10 to insure the oscillator is not disturbed by the address line

FIGURE 5. Typical Connection Diagram



Note 1: Must use 8238 or equivalent logic to insure advanced I/OW pulse, so that the ready output of the MM58167A is valid by the end of $\phi 2$ during the T2 microcycle

Note 2: $t_{\phi 2} \geq t_{RS8080} + t_{DL8238} + t_{WRY58167A}$

FIGURE 6. 8080 System Interface with Battery Backup

Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 7 of 8)

Block Diagram

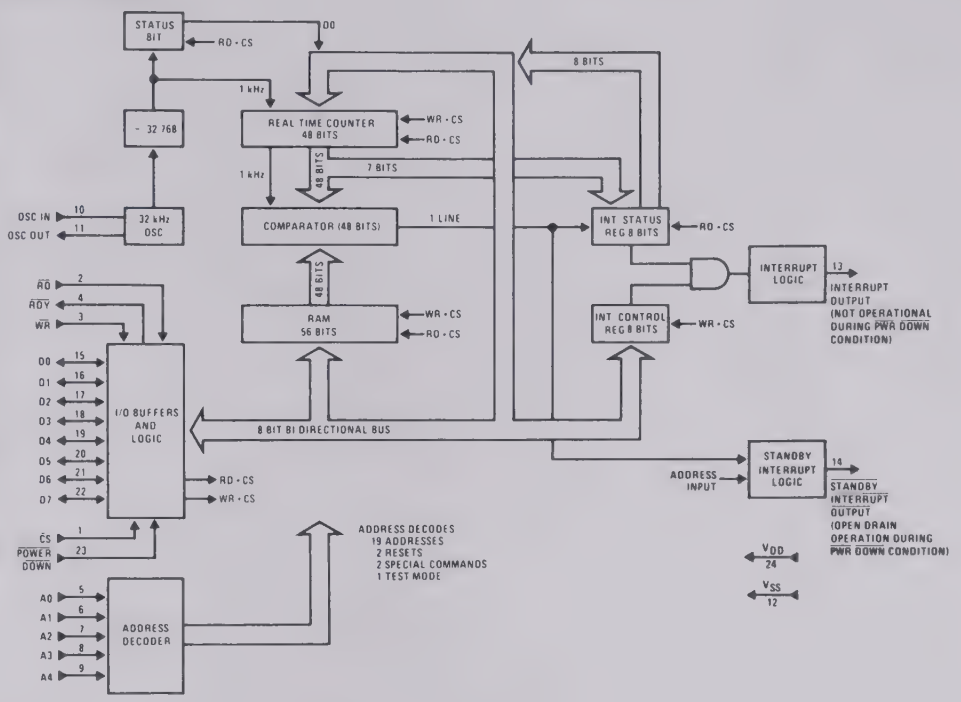
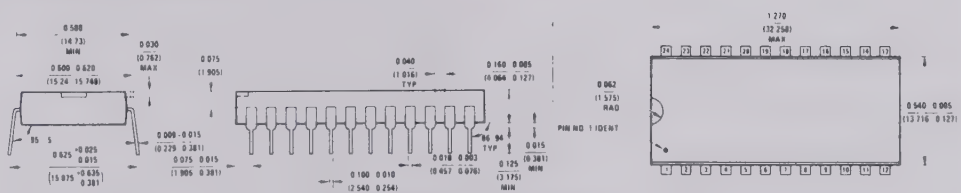


FIGURE 7

Physical Dimensions inches (millimeters)



Molded Dual-In-Line Package (N)
Order Number MM58167AN
NS Package Number N24A

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National Semiconductor Corporation
2900 Semiconductor Drive
Santa Clara, California 95051
Tel: (408) 737-5000*
TWX: (910) 339-9240
*After June 6, 1981, Call (408) 721-5000

National Semiconductor GmbH
Fürstenriederstrasse Nr. 5
8 München 21
West Germany
Tel: (089) 56 01 20
Telex: 522772

NS Japan K.K.
POB 4152 Shinjuku Center Building
1-25-1 Nishishinjuku, Shinjuku-ku
Tokyo 160, Japan
Tel: (03)349-0811
Telex: 232-2015 NSCJ-J

National Semiconductor (Hong Kong) Ltd
1st Floor
Cheung Kong Electronic Bldg.
4 Hing Yip Street
Kwun Tong
Kowloon, Hong Kong
Tel: 3-899235
Telex: 43866 NSEHK HX
Cable: NATSEMI HX

National Semiconductores Do Brasil Ltda
Avda Brigadeiro Faria Lima 830
8 ANDAR
01452 Sao Paulo, Brasil
Tel: 212-1181
Telex: 1131931 NSBR

NS Electronics Pty. Ltd.
Cnr. Stud Rd. & Mtn. Highway
Bayswater, Victoria 3153
Australia
Tel: 03 729 6333
Telex: 32096

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied, and National reserves the right, at any time without notice, to change said circuitry.

Figure 4.15. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 8 of 8)

"Dead-Man" Timer and Power-Down Circuits

The "dead man" timer consists of U18B and U26. In the absence of regular retriggering, periodic resets are generated by this circuit, allowing the microprocessor to recover from a "soft" error hangup condition. Associated with the dead-man timer is the power-down timer which flags a power down condition to the microprocessor, then restricts access to the nonvolatile RAM and clock as power goes down. The dead-man timer is retriggered by accessing any port 38H through 3FH.

The rechargeable Ni-Cad battery, BT1, is equipped to charge from the +5 volt supply when the unit is on. In the absence of applied power, the battery supplies sufficient power to keep the RAM contents valid and the clock running. The capacity of the battery is sufficient to keep these circuits functioning for 3 to 6 months without external power.

4.3.4.3 Bit Error Counter and External Event Monitor

4.3.4.3.1 Bit Error Counter Circuit

A block diagram of the Bit Error Counter, the Million Bit Interrupt Latch, and External Event Monitor Circuitry is shown in Figure 4.16.

This circuit accepts Bit Errors, and a million bit strobe from the ECL Logic PWB (A2). The outputs are an interrupt signal to the microprocessor every one million (10^6) clock cycles and a Bit Error Total for the microprocessor input.

The million bit strobe from the ECL Logic PWB is used to strobe the Octal D Registers (U85 and U87) which input data from the 15 Bit Error Counters (U83, U84, U86 and U95) at a time when the error counters are stabilized.

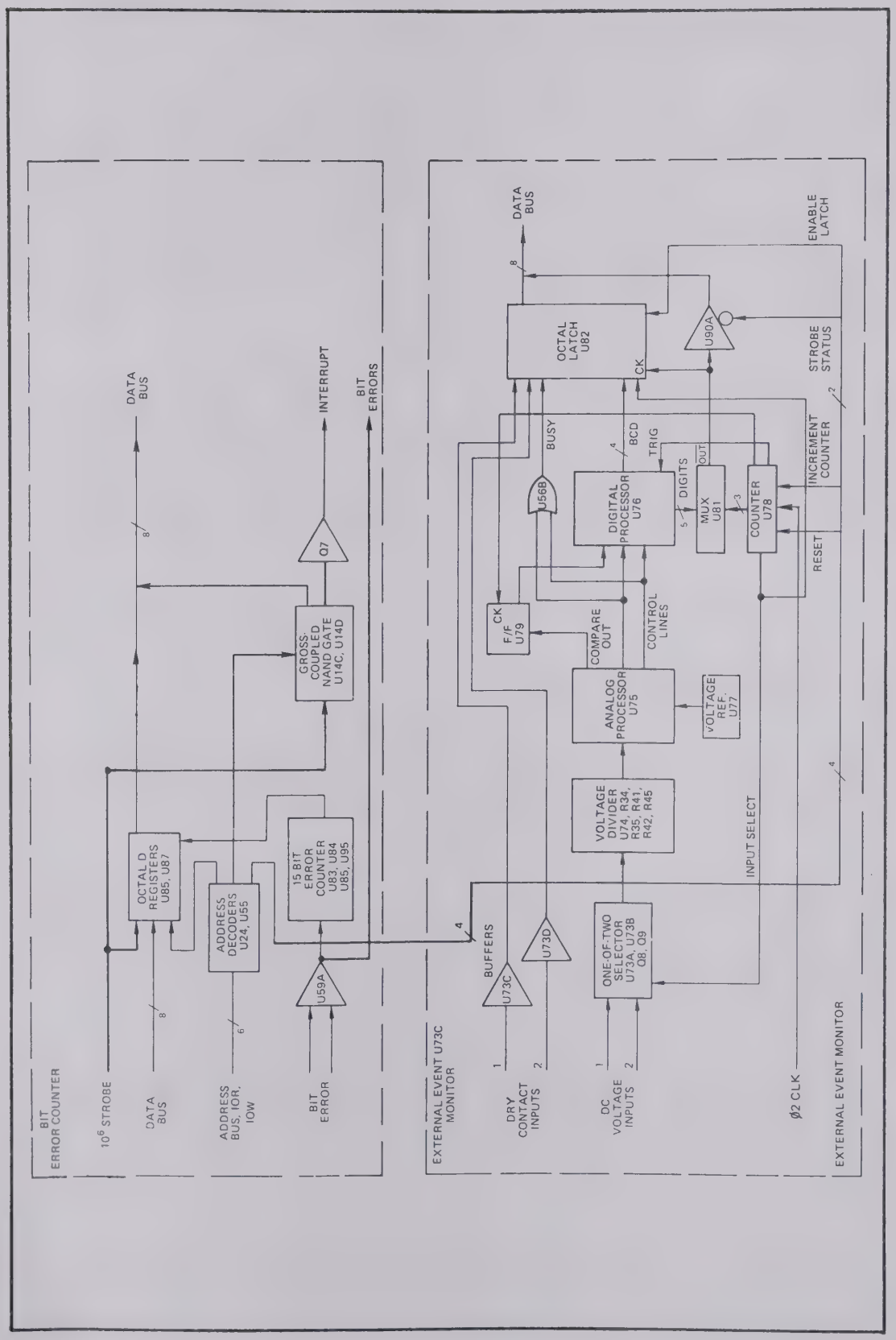


Figure 4.16. Model 4657B Processor PWB (A1) Bit Error Counter, Million Bit Interrupt Latch and External Event Monitor Circuitry, Block Diagram

Components U83, U84, U86, and U95 are used as a synchronous cascade counter. Since it is possible to have successive bit errors, the counter can tally errors at the 44.7 MHz clock rate. Having only a 22-nanosecond wide pulse, strobe timing is critical for U85 and U87 to latch a stable count. As U85 and U87 are strobed, the flip-flop action of Cross Coupled NAND Gate U88 is set to switch transistor Q7 to ON and generate an Interrupt signal. U88 also pulls data bus line D4 low when the MSB port of the bit error counter is read to tell the microprocessor that the interrupt was a million-bit interrupt. An Interrupt signal is provided to the micro- processor for every million bits counted. This enables the microprocessor to read accumulated errors per million cycles and perform other error rate calculations.

Component U55 decodes I/O Addresses in the range EØH to FFH from the microprocessor bus. When U65, pin 15, goes low, the address EØH has been decoded enabling the 3-state outputs of Register U85 to put the low order 8 bits of error count on the microprocessor data bus. Similarly, U55, pin 14, goes low when address E4H is decoded, enabling Register U87 to put the 7 high order error bits and the million bit interrupt status on the micro- processor bus.

4.3.4.3.2 External Event Monitor Circuits

The External Event Monitor circuit accepts two DC VOLTAGE inputs and two DRY CONTACT inputs, and operates at a 409.6 kHz clock rate. Its output consists of four bits to identify the BCD (binary coded decimal) value of the selected digit plus four control bits which are put onto the data bus.

The counter (U78) controls the sequencing of this circuit. Pins 5, 6, and 7 provide a count from 0 to 4 to the multiplexer (U81) thus selecting digits 1 through 5 to be input sequentially by the Digital Processor (U76). When the fifth digit is selected, pin 3 of U78 (INPUT SELECT) toggles. This causes U73A or U73B to turn on either Q8 or Q9. Thus the Digital Processor outputs first the BCD value of digits 1 through 5 for one input and then the other.

The selected input voltage is divided by the ratio of R45 to R34 + R35 (or R41 + R42), and limited by CR4 and CR5 (or CR6 and CR7). U77 provides a stable reference voltage for U75 (nominal 3.00V) by R52. This reference voltage provides U75's internal comparator with a half scale voltage reference point. Component U79 is arranged to form a D flip-flop clocked by the counter U78 so that the COMP OUT data of U75 will be clocked into the COMP IN input of U76 at the same rate at which the DC INPUTS are selected. The two control lines (A and B), when ORed together by U56B, provide an indication to the microprocessor that U75 and U76 are BUSY. U76 is triggered each time a new digit is selected by U78 pin 7. Therefore, a new four bit BCD value is output to the microprocessor through latch U82 for each of the five digits of each of the two input voltages.

The two dry contact inputs are buffered and converted to TTL levels by U73C and U73D and sent to the microprocessor through latch U82 each time a new BCD value is output.

4.3.4.4 BPV and Parity Error Counters

A block diagram of the BPV and Parity Error Counters is shown in Figure 4.17. These circuits count both bipolar violation errors and parity errors. A pulse on the 10^6 strobe transfers the error count into respective latches where it can be read by the microprocessor. There is also interface circuitry to allow the microprocessor to read the several status conditions and control the mode of operation of various circuits.

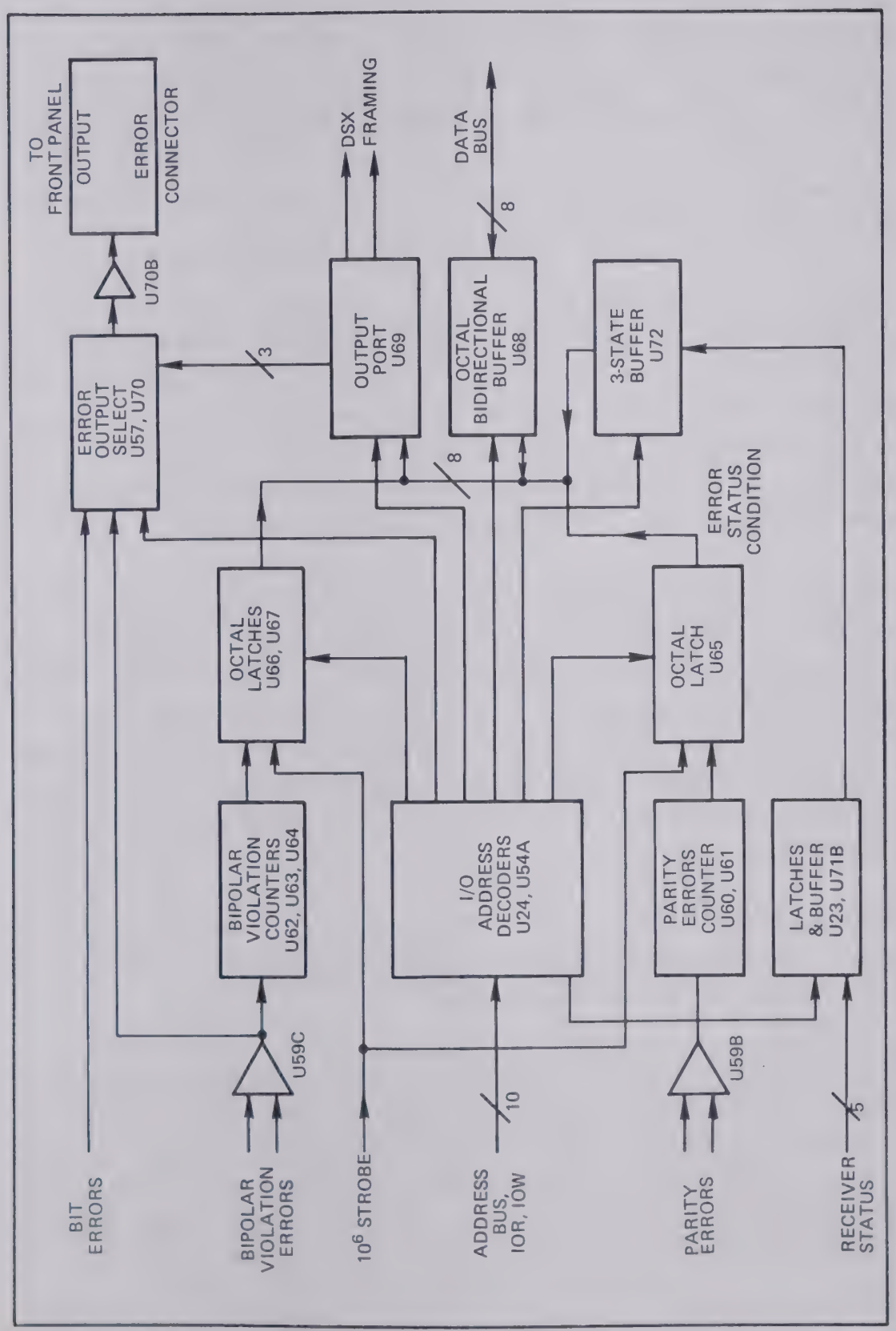


Figure 4.17. Model 4657B Processor PWB, BPV and Parity Error Counters Circuitry, Block Diagram

Cascaded synchronous counters U62, U63, and U64 total the bipolar violation count being applied through translator U59C from the B3ZS Decoder and Blue Signal Detector on the ECL Logic PWB (A2). The counter outputs are connected to octal latches U66 and U67 which latch the counter reading when pulsed by the 10^6 strobe. When U24 and U54A decode I/O Read addresses CØH and C8H, U67 and U66 are enabled, respectively, to place their data on the microprocessor data bus through octal buffer U68.

Similarly, counters U60 and U61 total the parity error count being applied through buffer U59B from the M-Frame Synchronizer on the ECL Logic PWB (A2). The count is latched into U65 when pulsed by the 10^6 strobe. When U24 and U54A decode read I/O address DØ, U65 is enabled to put the counter reading on the microprocessor data bus through octal buffer U68. Parity errors are totaled in an 8-bit counter since only one parity error can occur each superframe of 4760 bits, or 211 maximum per each 10^6 strobe cycle.

Component U68 is an Octal Bus Transceiver with 3-State outputs. It is enabled when an I/O address in the range CØH to FFH is active. The microprocessor controls the I/O Read function which, in turn, controls whether U68 is operated to the Input Mode or the Output Mode. Component U72 is an inverting 3-State Octal Buffer that is enabled by I/O read address D8H and allows the microprocessor to read the error status inputs from latch U23 as listed on the schematic (i.e., Loss of Signal, F-Frame, M-Frame, PRBS Sync, and BLUE Signal).

Octal Latch U66 also provides microprocessor access to the input from jumper J4. The jumper on J4 selects Synchronous Error Seconds when in place and Asynchronous Error seconds when removed.

Component U69 responds to I/O Output address D8H. Three of the five used outputs select which error type will be provided to the front panel OUTPUT-ERROR connector and the burst counter. One of the three gates, U57A, U57B, or U57C, will be enabled by a U69 output which is chosen to match the error type selected for display by the front panel switches. The selected signal is buffered by U70A which drives the $\overline{\text{Error}}$ line to the Burst Counter (U30). The

error output signal comes out of U70B, which is a 50Ω TTL line driver, and is sent to the front panel Error Output BNC (J7). During a signal loss, the CPU ϕ2 clock is gated in by U71A and U70B to provide a high error rate signal to the front panel output.

4.4 MODEL 4657B ANALYZER OPTIONS

There are three options available to expand the operation of a Model 4657 Error Rate Analyzer. They are designated as:

1. Option 304281: IEEE-488 Interface Bus
2. Option 304378: RS-232C Interface Bus
3. Option Model 4650: Printer

The following paragraphs provide description and theory of operation for these options. The information is provided in the same sequence as listed above. Options 304281 and 304378 are designed to plug into connector J6 on the Processor PWB (A1) and only one will be available at a time. Either option can be added to an analyzer at a later date by qualified maintenance personnel using the Installation Procedures provided in the Operator's Manual. Option Model 4650 is an external electromechanical printer that is compatible with the analyzer circuitry with or without Option 304281 or 304378.

4.4.1 Option 304281: IEEE-488 Interface Bus PWB

A block diagram of the IEEE-488 Interface Bus PWB is shown in Figure 4.18. The schematic for the optional IEEE-488 Interface Bus PWB is shown in Figure 7.17. The IEEE-488 Interface Bus PWB interfaces the Model 4657B Analyzer circuits to the IEEE-488 Interface Bus through a rear panel connector. These circuits are configured for I/O operation with a base address of AØH. (See Table 4.1.)

The IEEE-488 Interface Bus PWB provides the hardware interface to mate the Model 4657B Analyzer microprocessor system bus to the IEEE-488 bus in the Listener or the Talk configuration, but not as the system controller. Considerable software overhead is also required to initialize the 68488 integrated circuit, which contains the bus interface logic, and to process Controller commands. Once initialized with talker/listener protocol set-up, data transfer can flow smoothly using the available interrupts. IEEE Bus address switches are provided on the printed circuit board to establish talker/listener address definition.

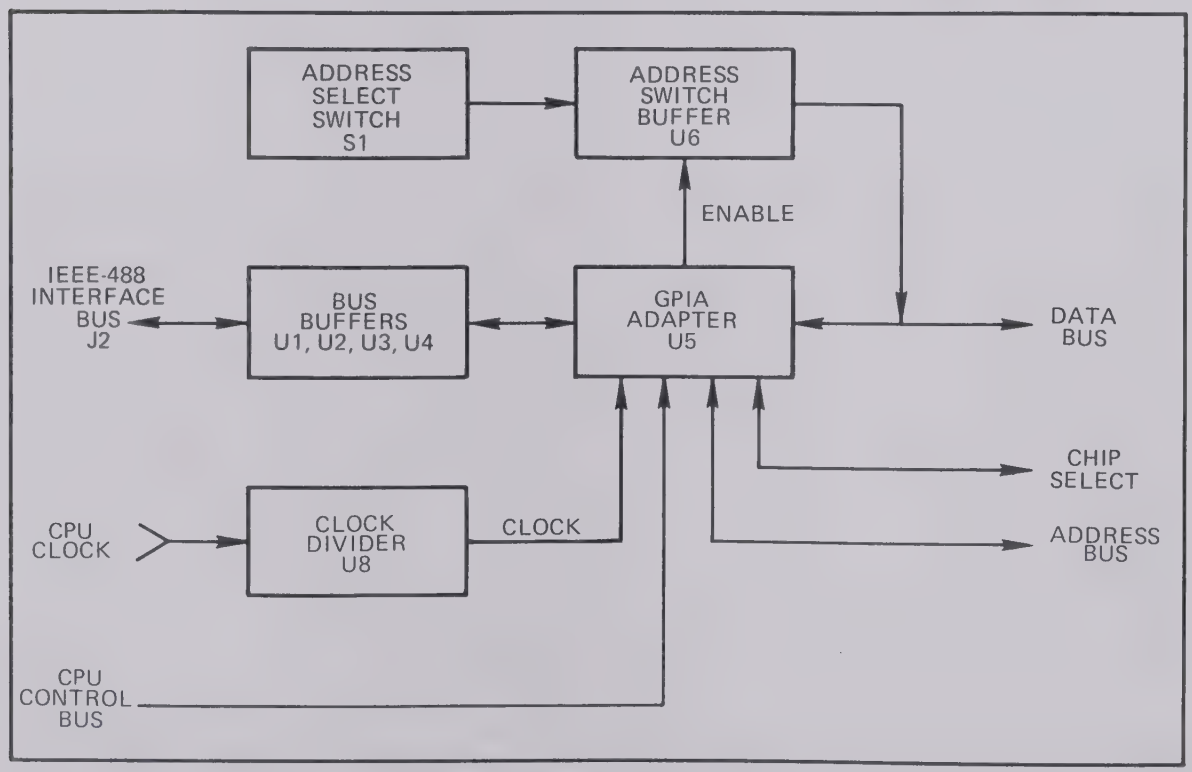


Figure 4.18. Model 4657B IEEE-488 Interface PWB (A6) (Option 304281), Block Diagram

To fully use the IEEE-488 Interface Bus PWB, the programmer must have a working knowledge of the IEEE-488 Interface Standard and Scientific-Atlanta adopted protocol. Descriptions in this section will be limited to port assignments and transfer of data with the 68488 IC. Some peculiarities of the software interface will not be described. For example, there is no explanation of how to process commands in the command pass through register or parallel poll register.

4.4.1.1 IEEE-488 Interface Bus PWB Specifications

Specifications applicable to the IEEE-488 Interface Bus PWB are as follows:

Primary Logic Element	- 68488 General Purpose Interface Adapter automatically handles all handshake protocol on the IEEE-488 bus.
Power Requirements	- +5.0V dc at 0.92 Amps (Max.)
IEEE Bus Connector	- Connector J2 is compatible with IEEE-488 standard bus interface cable.

4.4.1.2 Detailed Circuit Description

The IEEE-488 Interface Bus PWB contains a single LSI-IC which performs most of the bus logic. The remaining components provide the bus interface, buffering and decoding. The 68488 IC, U5, automatically handles all handshake protocol on the IEEE-488 bus. The IC's U1 through U4 buffer drive the IC-U5 I/O into IEEE-488 bus compatible levels. The remaining components are used to make the 68488 IC compatible with the 8080 microprocessor system.

The following detailed circuit descriptions do not explain operation of the logic or the operation of the IEEE-488 bus since these functions are accomplished internally to circuit of IC-U5. The descriptions do involve the connection of the IC-U5 between the IEEE-488 and the 8080 Microprocessor system bus.

IC-U5, The 68488. This single IC automatically handles all handshake protocol on the IEEE bus. Features provided by this circuitry include the following:

1. Single or dual primary address recognition
2. Secondary Address capability
3. Complete Source and Acceptor handshake
4. Programmable Interrupts
5. RFD hold-off to prevent data overrun
6. Serial and Parallel polling capability
7. Talk-only or listen-only capability
8. Synchronization trigger output

The 68488 is 6800 bus compatible and requires some adapter logic to make it 8080 bus compatible. The bus difference is basically that the 6800 is enabled and the clock input strobes data from the microcomputer bus into the IC, whereas the 8080 components are enabled and have separate I/O read and write pulses to strobe the data. The 68488 does not provide IEEE-488 bus termination and therefore requires the additional circuitry of bus drivers and terminators to provide buffering of the system data bus to the 8080 Microprocessor.

The schematic in Figure 7.17 shows that all of the 68488 IEEE bus connections are buffered into the IEEE bus. The DIOØ-DIO7 lines are bi-directional with T/$\overline{RZ}$ (pin 27) output controlling the U3 and U4 buffer direction. The functional direction of signals Data Available (DAV), Ready for Data (RFD), and Data Accepted (DAC) are also controlled by T/$\overline{RZ}$. Note that the functions labeled Attention (ATN), Remote Enable (REN), and Interface Clear (IFC) are always inputs. The function Service Request (SRQ) is always an output and the direction of End or Identity (EOI) is controlled by T/$\overline{RI}$ (pin 28).

The circuits provided by U1 through U4 include IEEE bus drivers and terminators to make the 68488 electrically IEEE bus compatible. The system data bus, DBØ through DB7, connect directly to the 8080 Microprocessor data bus.

The Address Switch Enable (ASE) function at pin 4 of the 68488 enables U6 to put the address switch setting onto the data bus when the microcomputer is addressing Register 4 (which is actually the switch setting). The Chip Select function (U5, pin 3) is enabled when addressed through decoders on the 4657B Processor PWB (A1). Register Select Inputs (RSØ, RS1, and RS2) connect directly to System Address Bits (ABØ, AB1, and AB2, respectively) to select the various registers for I/O data transfers.

The 68488 Clock Input (pin 6) is connected to a divide-by-two circuit of the 2.048 MHz Phase 2 Clock (ϕ2CLK) of the 8080 Microprocessor bus to produce a 1.024 MHz clock. Since the 68488 circuit uses the trailing edge of its clock input to strobe data for input, the clock input is also synchronized to the 8080 Microprocessor bus to correctly transfer data. This circuit is described later under the paragraph title "68488 Clock Synchronizing Circuit".

The 68488 Read/Write (R/W) function is connected to $\overline{\text{IOW}}$ (for Normal I/O). The reset line connects directly to the system control bus for system resets. The Interrupt Request (IRQ) output is connected to the microprocessor $\overline{\text{INT}}$ line. The jumper on J3 allows disabling of the interrupts from the IEEE-488 PWB while it is still plugged into the 4657B.

68488 Clock Synchronizing Circuit. The 68488 IC is a dynamic device requiring continuous clocking with a frequency between 100 kHz and 1.0 MHz. Additionally, during I/O transfers, the trailing edge of the clock signal latches bus data into one of the eight addressed latches. The U8-D flip-flop is used to divide the 8080A Microprocessor 2.048 MHz Phase 2 Clock down to 1.024 MHz.

The phase of the flip-flop is controlled by gating the U8 internal feedback (U8, pin 6 shown as $\overline{Q}$ output) with the sync signal on the 8080 Microprocessor control bus. If the sync pulse is high during the T1 cycle of the 8080 Microprocessor, and if the U8 Q output (pin 5) is low at the beginning of T1, it is allowed to switch high on the next clock pulse. If the U8 output is high at this time interval, it is held high. The U5 clock input is now synchronized with the 8080 Microprocessor data transfer and produces a clock trailing edge during data valid on load to U5 data transfers.

Address Switch Enable. Register 4, shown on the 68488 data sheet, does not actually exist within the 68488 IC. During "reads" from this register, the 68488 outputs the inverted Address Switch Enable (ASE) at pin 4 which is used as an enable for a data bus buffer and puts the switch setting on the data bus.

The IEEE bus address switch S1 is an eight-position single pole switch with pull-up resistors provided by U10 and connected to U6 operating as an octal 3-state data bus buffer. When U6 is enabled by ASE, an address switch setting is put on the data bus to be read by the 8080 Microprocessor. Note that during initial power-up of the 68488, this address has to be read by the 8080 Microprocessor and then loaded into the 68488 address register to define the IEEE bus address for the 68488. This is only done at power-up. The IEEE-488 bus address is a 5-bit address and the other 3 switch positions can be user defined through software for a desired function, such as talk-only or listen-only definition.

4.4.2 Option 304378: RS-232C Interface Bus PWB

A block diagram of the optional RS-232C Interface Bus PWB is shown in Figure 4.19. The schematic is shown in Figure 7.13. The RS-232C Interface PWB interfaces the Model 4657B Analyzer circuits to a compatible modem or terminal through a rear panel connector. These circuits are configured for I/O operation using the addresses of 8ØH through 9FH.

The block diagram of the RS-232C Interface PWB (Figure 4.19) shows that the circuitry basically provides a Serial I/O function, a Programmable Timer function, and a Rate Multiplier function.

The $\phi 2$ clock at 2.048 MHz is multiplied by 9/10 in the decade rate multiplier (U3) and provided to the 8253 timer (U2) as CLKØ at 1.8432 MHz. The 8253 timer divides down from this signal in accordance with baud rate that is set on DIP switch S1, and provides the 8251A USART (U11) with a TX/RX clock at 16X the operational baud rate. (Note that the baud rate switches are only read at power-up. The unit must be turned off and back on if the baud rate is changed.)

The 8251A USART handles all asynchronous data communication between a System Controller (through a compatible modem) and the Model 4657B Analyzer. Interface buffers (U8 and U9) are provided to the 8251A serial I/O lines to allow EIA RS-232 signal levels. The buffers also provide that compatible output signals identified as Data Terminal Equipment (DTE) or Data Communication Equipment (DCE) will be as specified in RS-232C. The RS-232C Interface PWB uses ports 8ØH and 84H for the 8251A programmable interface component, ports 88H, 8AH, 8CH, and 8EH for the 8253 programmable timer component, port 9ØH to increment timer #2 in the 8253, and port 98H to read the baud rate port.

Power Requirements

+5.0V dc at 0.40 Amps (Max.)
+12.0V dc at 0.025 Amps (Max.)
-12.0V dc at 0.05 Amps (Max.)

RS-232 Interface Connector

Connector J9 is compatible with a standard 25-pin D-type male connector.

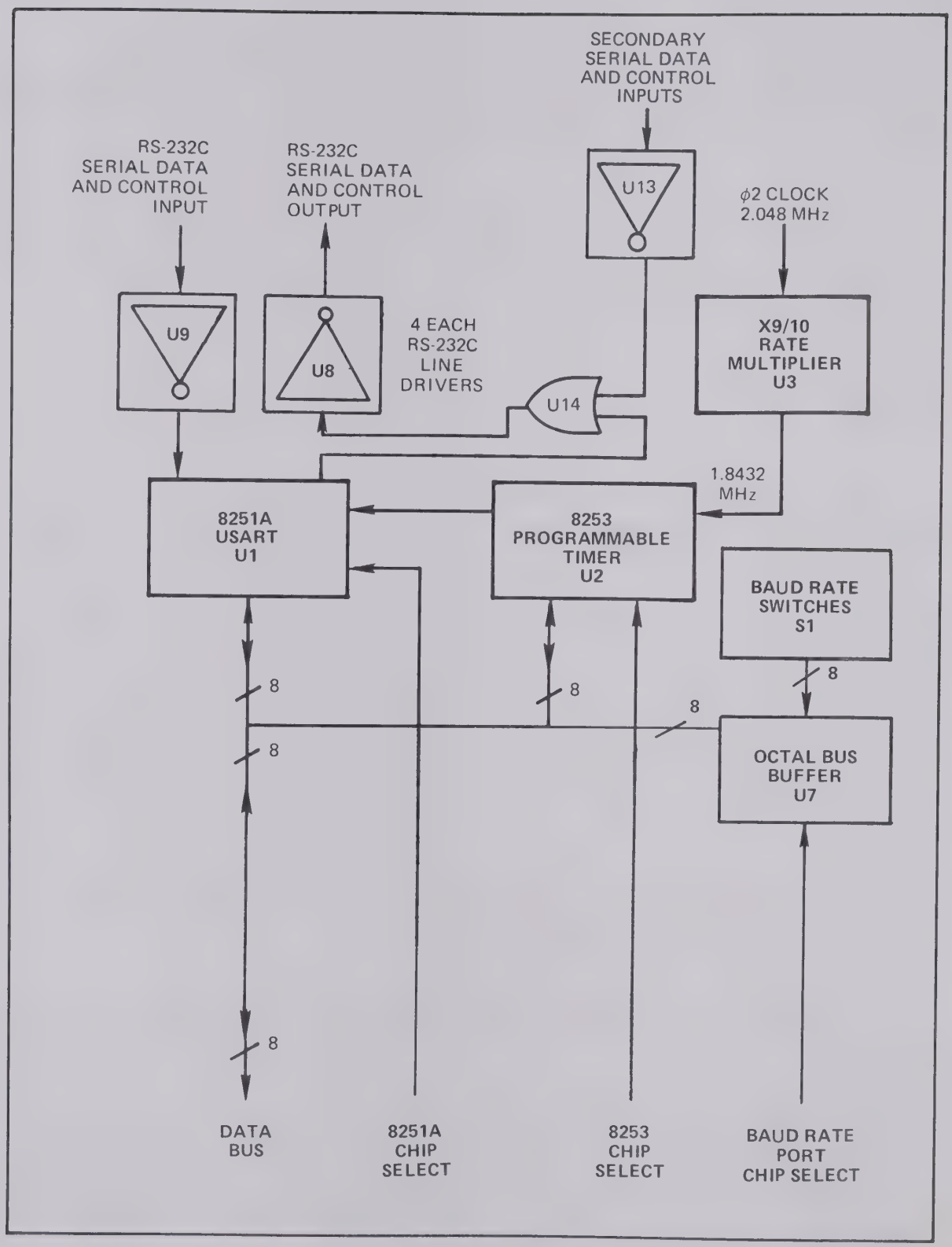


Figure 4.19. Model 4657B RS-232C Interface PWB (Option 304378), Block Diagram

Mating Connector and Pinout Chart

The RS-232C PWB Interface functions are provided through a 40-pin header located on the bottom of the printed wiring board. All signal pinouts are labeled on the schematic (see Figure 7.13).

4.4.2.1 Detailed Circuit Description RS-232C Interface PWB

The circuit components used by the RS-232C Interface PWB are 8080 Processor bus compatible and should be considered as system elements rather than individual components. The necessary jumpers and the proper command sequences have been identified in Chapter 3 of the Operator's Manual to prepare this PWB to be compatible with the Model 4657B Analyzer in most common environments. The following paragraphs identify other features available but not generally used in equipment of this design.

4.4.2.1.1 EIA RS-232 DCE or DTE Arrangement

Three pairs of signal wires must be cross connected for the DCE or DTE configuration if the signals are to be used. There are many applications which use transmit data (TXD) and receive data (RXD) only and do not connect the Data Terminal Ready (DTR), Data Set Ready (DSR), Request to Send (RTS) and Clear to Send (CTS) functions.

The six signal functions should be wired according to one of the following tables to complement the equipment configuration:

DCE Arrangement
- RXD: jumper J2 pins 1 and 3
- TXD: jumper J2 pins 2 and 4

Optional
- DTR: jumper J4 pins 2 and 4
- DSR: jumper J4 pins 1 and 3
- RTS: jumper J3 pins 2 and 4
- CTS: jumper J3 pins 1 and 3

DTE Arrangement
- RXD: jumper J2 pins 4 and 6
- TXD: jumper J2 pins 3 and 5

Optional
- DTR: jumper J4 pins 3 and 5
- DSR: jumper J4 pins 4 and 6
- RTS: jumper J3 pins 3 and 5
- CTS: jumper J3 pins 4 and 6

The RS-232 PWB has been designed so that two different units, such as a Model 4657B Analyzer and a Model 4641 Scanning Switch, can be daisy-chained on the same RS-232 line. To do this requires a special cable available from

Scientific-Atlanta (Part No. 313372). It also requires that the jumpers on J10, J11, and J12 be set to the DSY position. If the board is not to be used in this mode, these jumpers must be set to the single unit position (SGL). (See Figure 3.16 in the Operator's Manual.)

4.4.2.1.2 Serial Interrupts

Three interrupt functions are available at the 8521 Programmable Communication Interface circuit arrangement. These functions are: (1) TXE (Transmit Empty) which will provide indication that transmit register and transmit buffer register is empty, (2) TXRDY (Transmit Ready) which will provide indication that the transmit buffer is empty and the transmitter is sending the last byte, and (3) RXRDY (Receive Ready) which will provide indication that the receiver buffer is full and should be ready. On this board the TXRDY and RXRDY are ORed together and connected to the microprocessor interrupt line.

Loading the transmit buffers and reading the receive buffer will reset the corresponding interrupt function.

4.4.2.1.3 8251A Programmable Communication Interface (U6)

The 8251A Programmable Communications Interface component U6 operates (1) bi-directionally with the data bus, (2) using Address AB2 to select the internal command or data register, (3) using various control bus lines to manage the data transfer, (4) using the U1 timer outputs to set the band rates, and (5) using the U7 and U8 circuits to produce EIA RS-232 levels.

The U1 data bus is bi-directional with direction controlled by the $\overline{\text{IOR}}$ and $\overline{\text{IOW}}$ signals with buffering onto the system bus provided through the operation of component U91 on the Processor PWB (A1). The 8251A circuit has command and data transfer modes which are selected by the address AB2. (It should be noted that several command modes are multi-byte sequences to the same address and must be accomplished in a correct sequence.) The address AB2-low selects data and AB2-high selects command and status. The system

control bus signals used are RESET for initialization, and $\overline{IOR}/\overline{IOW}$ for outputting/inputting data to/from the data bus, respectively.

The Transmit Clock (TXC) function (U6, pin 9) and the Receive Clock (RXC) function (U6, pin 25) are wired together on the printed wiring board. This restricts the U6 circuit to transmitting and receiving at the same rate. The TXC and RXC functions have a common connection to the timer Ø in the 8253 to set the data transfer rate. The 8251A serial outputs: (1) are at TTL drive levels, (2) are unipolar, and (3) in order to be EIA RS-232 compatible, must be level shifted and made bipolar. Similarly, RS-232 bipolar inputs must be shifted to TTL levels for normal operation.

The 1488-line driver (U8) can input the TTL levels from U1 and output the required +12/-12V bipolar RS-232 signal levels required for functions TX, Syn Det, RTS, and DTR, as shown on the schematic. The 390 pF capacitors connected on the U8 outputs control the signal rise time to be RS-232 compatible.

The 1489-line receivers (U9, U13) are used to accept bipolar RS-232 signal inputs and provides TTL logic level outputs. The 0.001 capacitors used on the signal inputs provide RC filtering of the received signal. The 39K resistor will shift the threshold level slightly positive so TTL level inputs may also be used.

4.4.2.1.4 8253 Programmable Interval Timer (U1)

The 8253 Programmable Interval Timer (U2) will: (1) operate bi-directionally with the data bus and (2) use various control bus lines to manage the data transfer. Component U2 is provided with clock and gate inputs and outputs. The U2 data bus is bi-directional with the direction being controlled by the $\overline{IOR}$ and $\overline{IOW}$ signals.

The $\overline{IOR}$ and $\overline{IOW}$ are the only control bus inputs and provide control of the data read and write functions. Addresses AB1 and AB2 are input from the address bus and select the appropriate internal data registers. The clock Ø input (pin 9) is connected to the output of U3 which produces the 1.8432 MHz clock from the CPU ϕ2 clock. Clock inputs 1 and 2 are not used. The clock Ø

output of U2 is connected to U1, pins 9 and 25 to supply the transmit and receive clock for the selected baud rate. A 10K pull-up resistor SIP (U5) on the U1 input is provided to enable the gate inputs (U2, pins 11, 14, and 16) and to terminate unused clock inputs.

4.4.3 Option Model 4650: Dot Matrix Printer

The Dot Matrix Printer consists of several major components. The printer mechanism and Control/Drive Card are purchased items and not manufactured by Scientific-Atlanta, but the remaining components (i.e., case, Printer I/O PWB, and switch) are made to Scientific-Atlanta specifications with assembly and final testing provided by Scientific-Atlanta. Consequently, the printer mechanism and Control/Drive Card are not considered field repairable although this publication reprints some information from the Users Manual provided by Star Micronics, Inc., 200 Park Avenue, Pan Am Bldg., suite 2308, New York, NY, 10166, to assist troubleshooting should the need arise. This information follows the description of the Scientific-Atlanta Printer I/O PWB and Switch Panel.

4.4.3.1 Printer I/O PWB, 4650 (A2)

The Dot Matrix Printer I/O PWB is contained in the Dot Matrix Printer housing and interfaces with the Model 4657B through the W1 cable. The schematic diagram for the Printer I/O PWB is shown in Figure 7.5. The Printer I/O PWB interfaces the Control and Data Bus from the Processor PWB (A1) to the printer Control/Drive Card so the data bit lines of the printer controller (DBØ to DB7) are connected to PBØ to PB7, respectively, on the Processor PWB. The remaining lines are connected as follows:

Printer Function	8080 Processor PWB
$\overline{WR}$	PCØ
$\overline{RESET}$	PC3
$\overline{ERROR}$	PC4
$\overline{BUSY}$	PC5
$\overline{LOG\ ON}$	PC6
No Paper	PC7

The PCØ and PC3 lines are outputs from the Processor PWB to control the printer following the data transfer timing sequence illustrated in Figure 4.20.

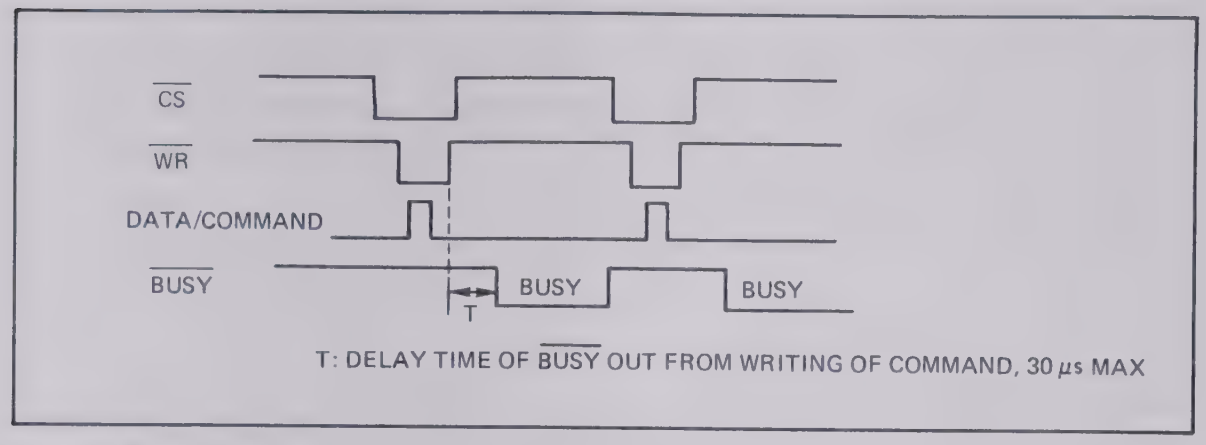


Figure 4.20. Dot Matrix Printer, Timing Sequence for Writing Character Data

The lines PC4 through PC7 are inputs to the Processor PWB to determine the status of the printer. Transistor Q2 inverts the RESET line from the Processor PWB to be the correct polarity required by the Control/Drive Card controller. The collector of transistor Q1 will pull LOG ON line function to ground (or to OFF state) whenever power is applied to the printer and the line function senses an open collector or no connection. A leaf-type microswitch (S1) provides the Paper Sense function which is required to protect the print head. The print head can prematurely wear out by attempting to print with no paper to absorb the shock of the printing needles. Components L1, C1, and C2 filter the 3.5 Ampere surge present when the print motor starts and, during operation, smooth the transients generated by the print head solenoids. Connector J3 interfaces both the POWER switch and PAPER ADVANCE switch on the front panel. When the POWER switch is operated to ON, connector pins J3-8, J3-9 are connected to J3-6, J3-7; and J3-4, J3-5 are connected to J3-2, J3-3. Operating the PAPER ADVANCE switch shorts J3-11 to J3-12.

4.4.3.2 Dot Matrix Printer Components

The Star Control/Drive card is equipped with an 8-bit parallel interface and is designed exclusively for the Star Series DP-822 (21 column) dot matrix impact printer. The card includes all drive electronics and control logic, an original Series DPC LSI printer controller chip, print solenoid drivers, motor driver, paper feed solenoid driver, timing signal waveform shaping circuit, and a 6 MHz quartz crystal. The Star DP-series dot matrix printers can be fully controlled by a microcomputer system through its data and control bus. A block diagram of the Control/Drive card is shown in Figure 4.21.

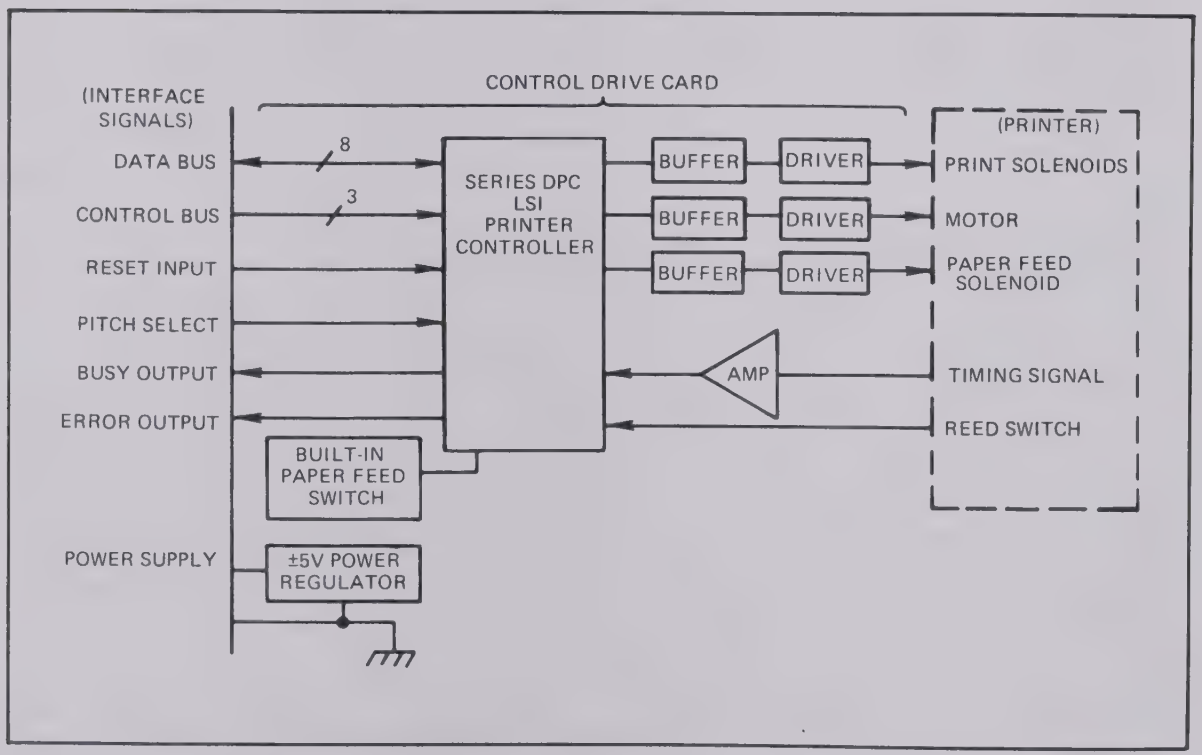


Figure 4.21. Dot Matrix Printer, Control/Drive Card, Block Diagram

Specifications for the Dot Matrix Printer are as follows:

Star Printer Model No.	DP-822-08B
Controller	DPC-1
Marking on LSI	D8041C 534
Character Buffer	21
Character Set	64 ASCII character set and 5 symbols
Pitch Select (columns)	18/21
Power Supply (V dc)	+12 (+10/-5%)
Power Consumption	
Operation (peak)	3.5 Amps
Stand-by (max.)	150 mA
Temperature (Celsius)	
Operating	+5.0° to +40°
Storage	-20 to +70°
Humidity (RH in %)	
Operating	30 to 80
Storage (max.)	95 to 40
Dimensions	4 in. x 6-5/16 in. (101 mm x 161 mm)
Interface Connector (CN1)	All inputs TTL compatible

Detailed Characteristics. The following entries provide some detailed characteristics of the dot matrix printer identified as Option Model 4650 for use with the Model 4657B Analyzer. This information is part of the "User's Manual for the Dot Matrix Printer Control/Driver Card" from Star Micronics, Inc., 200 Park Avenue, Pan Am Bldg., Suite 2308, New York, NY, 10166.

4.4.3.2.1 Controller

The Control/Driver Card incorporates a special LSI controller chip component which provides the following features:

- Microprocessor compatible 8-bit DATA Bus with three device control signal inputs (i.e., $\overline{CS}$, $\overline{RD}$, and $\overline{WR}$); two status output signals (i.e., $\overline{ERROR}$ and $\overline{BUSY}$); and three additional control signal inputs (i.e., $\overline{RESET}$, CP, and $\overline{FSW}$).

- A 5-x-7 matrix character generator for a 64-ASCII character set.
- A one-line print buffer (21 characters max.)
- A programmable multiple line feed.
- Off-line test printing capability.
- Machine error detection capability.

4.4.3.2.2 Discrete Electronics

Components for the following circuits are included:

- Print solenoid driver
- Paper Feed solenoid driver
- Timing signal buffer (or pulse shaping circuitry)
- A +5.0V dc power regulator

4.4.3.2.3 6.0 MHz Crystal

A 6.0 MHz quartz crystal is provided on the Control/Drive Card to supply a stable and fast clock timing for the DPC controller circuits.

4.4.3.2.4 Paper Feed Switch

A paper feed switch is provided on the Control/Drive Card for easy advancing of the paper supply. This switch can also be used for a test printing function.

4.4.3.2.5 Connectors

Four connectors are provided on the Control/Drive Card. Their general functions and mating connectors are identified in the table below.

Connector	Function	Mating Connector
CN1	Communicating with a microcomputer system	MOLEX 5049-15A
CN2	Connections for power supply, ground, and external paper feed input signal	MOLEX 5049-10A
CN3	Control/Drive Card signals to print head solenoids	UNION MACHINERY L25-014
CN4	Control/Drive Card signals for printer control	(Not applicable)

4.4.3.2.6 Interfacing

A block diagram showing the relationship of the Control/Drive Card connectors and their functions is shown in Figure 4.22. Connector pinout identification is provided in Table 4.2.

Table 4.2
Dot Matrix Printer,
Control/Drive Card Connector Pinout Identification

CN1

(for communicating with a microcomputer system)

Pin #	Pin Name	Description
1	$\overline{\text{ERROR}}$	Error Output
2	$\overline{\text{BUSY}}$	Busy Output
3	DB7	Data Bus b8
4	DB6	Data Bus b7
5	DB5	Data Bus b6
6	DB6	Data Bus b5
7	DB7	Data Bus b4
8	DB8	Data Bus b3
9	DB9	Data Bus b2
10	CP	Character Pitch Select In
11	DBØ	Data Bus bl
12	$\overline{\text{WR}}$	Write Input
13	$\overline{\text{RESET}}$	Reset Input
14	$\overline{\text{RD}}$	Read Input
15	$\overline{\text{CS}}$	Chip Select Input

CN2

(for power supply & ext. paper feed)

Pin #	Pin Name	Description
1	PFSW (+)	Ext. Paper Feed Switch
2	PFSW (-)	
3	GND	Ground (0V)
4	GND	
5	NC	(+5V out of monitoring)
6	MOTOR GND	Ground for Motor (0V)
7	MOTOR GND	
8	FRAME	Ground for Printer Frame
9	V_{IN}	+12V for 12V dc printers
10	V_{IN}	

Table 4.2 (continued)

CN3

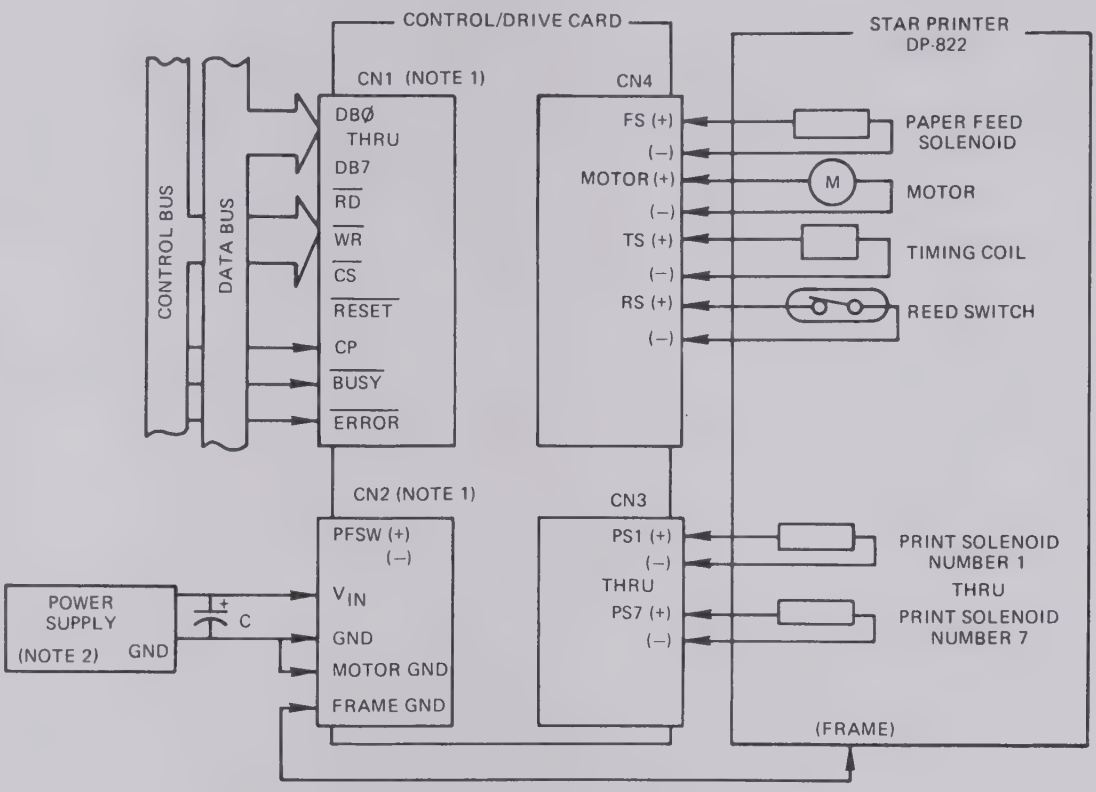
(for print head solenoids)

Pin #	Pin Name	Description
1	PS7 (-)	Print Solenoid for #7 Needle
2	PS7 (+)	
3	PS6 (-)	Print Solenoid for #6 Needle
4	PS6 (+)	
5	PS5 (-)	Print Solenoid for #5 Needle
6	PS5 (+)	
7	PS4 (-)	Print Solenoid for #4 Needle
8	PS4 (+)	
9	PS3 (-)	Print Solenoid for #3 Needle
10	PS3 (+)	
11	PS2 (-)	Print Solenoid for #2 Needle
12	PS2 (+)	
13	PS1 (-)	Print Solenoid for #1 Needle
14	PS1 (+)	

CN4

(for printer control)

Pin #	Pin Name	Description
1	NC	
2	RS (-)	Reed Switch
3	RS (+)	
4	TS (-)	Timing Signal
5	TS (+)	
6	NC	
7	FS (-)	Paper Feed Solenoid
8	FS (+)	
9	MOTOR (-)	Motor
10	MOTOR (+)	



NOTES:
1. CONNECTIONS FOR CONNECTORS CN1 AND CN2 MUST BE WIRED CAREFULLY. REVERSE CURRENT WILL DAMAGE COMPONENTS.
2. POWER SUPPLY REQUIREMENTS:
   VOLTAGE: +12V (+10/–5%)
   CURRENT: 3.5 AMPS PEAK
   CAPACITOR: 10,000 μF RECOMMENDED

Figure 4.22. Dot Matrix Printer, General Interface Functions of the Control/Drive Card Connectors, Block Diagram

4.4.3.2.7 Mounting Considerations

The nominal dimensions of the Control/Drive Card are shown in Figure 4.23.

4.4.3.2.8 Operation

The Control/Drive Card is capable of communicating with a microcomputer through the DPC Controller bi-directional 8-bit data bus and device control signals. The device control signals and two status output signals are described in the following paragraphs, and Table 4.3 lists the character coding set that is unique to the operation of the Dot Matrix Printer. (See Figures 4.24 thru 4.27 for component locations and schematics for the Control/Drive Cards.)

Table 4.3
Dot Matrix Printer, Character Coding Set

				b8	0	0	0	0	0	0	0	0	1	1
				b7	0	0	0	0	1	1	1	1	1	1
				b6	0	0	1	1	0	0	1	1	1	1
b4	b3	b2	b1	col / row	0	1	2	3	4	5	6	7	E	F
0	0	0	0	0			SP	0	@	P				
0	0	0	1	1		DC1	!	1	A	Q				
0	0	1	0	2			"	2	B	R				
0	0	1	1	3			#	3	C	S				
0	1	0	0	4			$	4	D	T				
0	1	0	1	5			%	5	E	U				
0	1	1	0	6			&	6	F	V				
0	1	1	1	7			'	7	G	W				
1	0	0	0	8			(	8	H	X				
1	0	0	1	9			)	9	I	Y				
1	0	1	0	A	LF		*	:	J	Z				
1	0	1	1	B			+	;	K					
1	1	0	0	C			,	<	L					
1	1	0	1	D			-	=	M					
1	1	1	0	E			.	>	N					
1	1	1	1	F			/	?	O	_				

LF = Print/Paper Feed Command
DC1 = Controller Reset Command

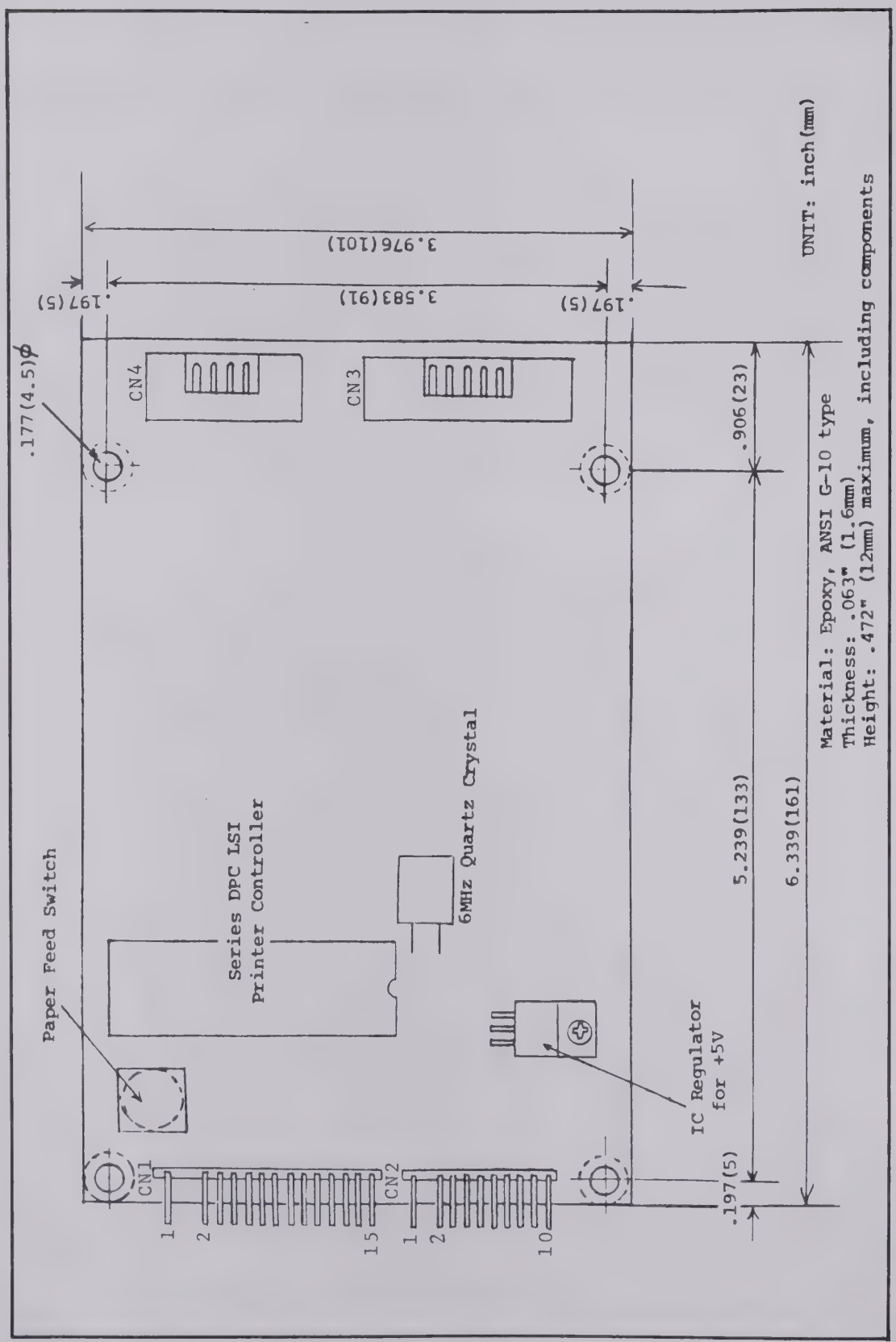


Figure 4.23. Dot Matrix Printer, Dimensions of the Control/Drive Card

1. Device Control Signals. The operation mode of the Control/Driver Card is selected by shifting the three device control signals as shown below.

$\overline{CS}$	$\overline{WR}$	$\overline{RD}$	Mode	Data Bus
0	0	0	PROHIBITED	character data/command status
0	0	1	WRITE	
0	1	0	READ	
0	1	1	NO OPERATION	
1	x	x	DISABLING	

2. Reading Status of Data Bus Buffer.

$\overline{CS}$ = 0	DBB:	D7	D6	D5	D4	D3	D2	D1	D0
$\overline{WR}$ = 1	x	x	x	x	x	B	I	x	
$\overline{RD}$ = 0									

IBF = Input-Buffer-Full status

BUSY status

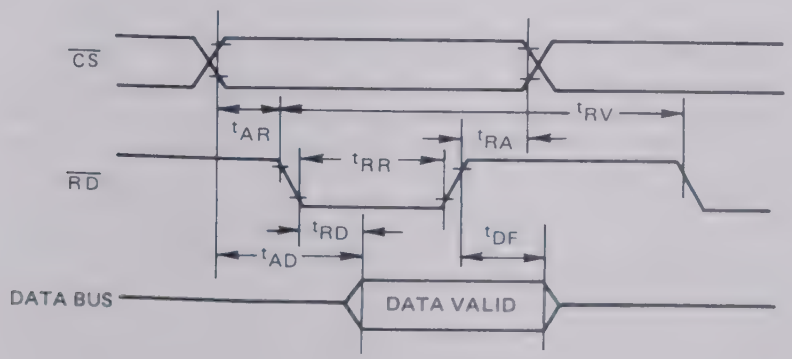
BUSY = 1 Busy
= 0 Not busy = Ready

Busy status is "1" during its processing the data entered or execution of the command. It must be "0" for new entry of data or command.

IFB = 1 Input buffer full
= 0 Input buffer clear

When a character or command is entered, it will be stored in an Input Buffer temporarily making the Input-Buffer-Full status "1". And when the data or command is processed, this IBF status becomes "0". It must be "0" for new entry of data or command.

Timing for Reading Status



DBB Read

SYMBOL	PARAMETER	MIN	MAX	UNIT
t_{AR}	$\overline{CS}$ Setup to $\overline{RD}\downarrow$	0		ns
t_{RA}	$\overline{CS}$ Hold after $\overline{RD}\uparrow$	0		ns
t_{RR}	$\overline{RD}$ Pulse Width	250	5000	ns
t_{AD}	Delay, $\overline{CS}$ to data out		150	ns
t_{RD}	Delay, $\overline{RD}$ to data out		150	ns
t_{DF}	Delay, $\overline{RD}$ to data float	10	100	ns
t_{RV}	Recovery Time between RDs	1		µs

3. Writing character Data.

$\overline{CS}$ = 0
$\overline{WR}$ = 0
$\overline{RD}$ = 1
BUSY = 0
IBF = 0

DBB:	D7	D6	D5	D4	D3	D2	D1	D0
	b8	b7	b6	b5	b4	b3	b2	b1

This character data must be ASCII-coded.
Table 2 page 8 shows a character coding set of acceptable ASCII characters and symbols.

4. Writing Command.

a) Print/Paper Feed Command LF = $0A_H$

$\overline{CS}$ = 0
$\overline{WR}$ = 0
$\overline{RD}$ = 1
BUSY = 0
IBF = 0

DBB:	D7	D6	D5	D4	D3	D2	D1	D0
	0	0	0	0	1	0	1	0

When this command follows the writing of character data, the printer starts to print the data and advances the paper one line. Then the character data will be cleared from the line buffer in the series DPC controller.

If this command is entered without a preceding transfer of data, it is treated as a paper feed command.

Programmable Multiple Line Feed
In addition, if the entry of this command is followed by an entry of data representing a number in binary code, the printer feeds the paper as many lines as programmed by this number.

DBB:	D7	D6	D5	D4	D3	D2	D1	D0
	0	0	0	n4	n3	n2	n1	n0

(programmable up to 31 lines)

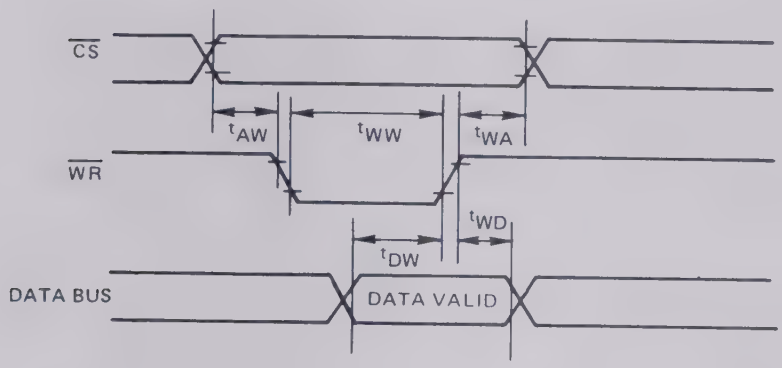
b) Reset Command DC1 = 11_H

$\overline{CS}$ = 0
$\overline{WR}$ = 0
$\overline{RD}$ = 1
BUSY = 0
IBF = 0

DBB:	D7	D6	D5	D4	D3	D2	D1	D0
	0	0	0	0	1	0	1	0

When this command is entered, a preceding transfer of character data or command, if any, will be cancelled as well as ERROR output.

Timing for Writing Character Data and Commands



DBB Read

SYMBOL	PARAMETER	MIN	MAX	UNIT
t_{AW}	$\overline{CS}$ Setup to $\overline{WR}$↑	0		ns
t_{WA}	$\overline{CS}$ Hold after $\overline{WR}$↑	0		ns
t_{WW}	$\overline{WR}$ Pulse Width	250	5000	ns
t_{DW}	Data Setup to $\overline{WR}$↑	150		ns
t_{WD}	Data Hold after $\overline{WR}$↑	0		ns

Parts Layout - Model 822-08A

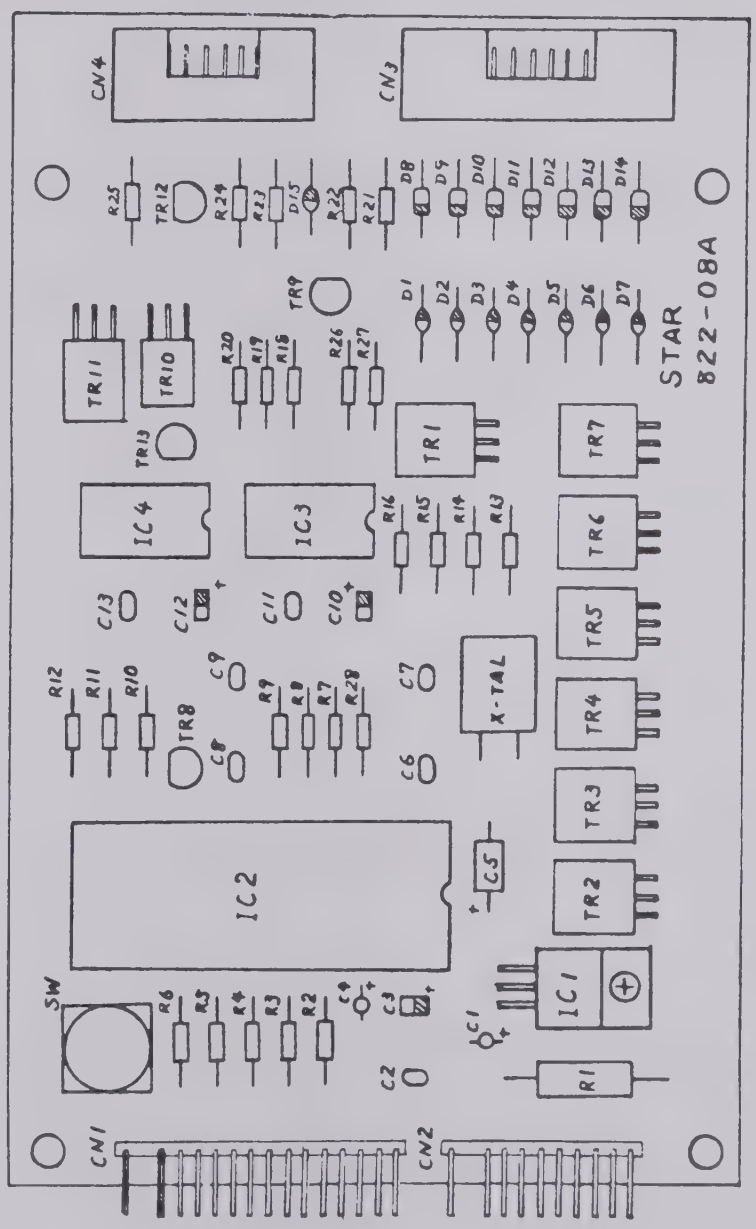


Figure 4.24. Control/Drive Card for Dot Matrix Printer Model 822-08A, Component Location

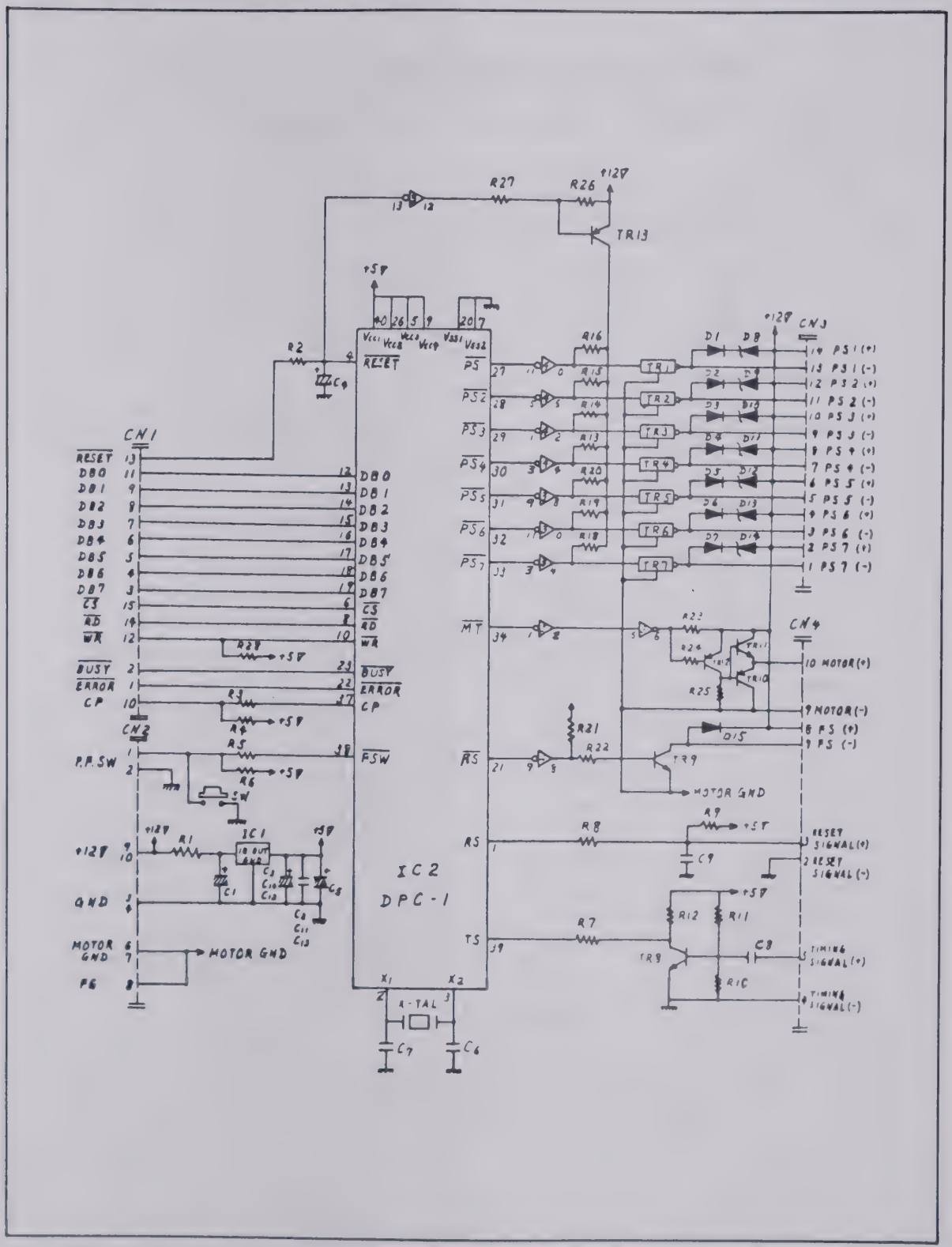


Figure 4.25. Control/Drive Card for Dot Matrix Model 822-08A, Schematic Diagram

Parts List of Control/Drive Card for Model 822-08A

Type of Component	Star Part Number	Description	Qty.	Mfr's Number or Characteristics	Supplier
P.C. Board		Two-sided	1	822-08A	
IC	IC2	LSI, custom	1	DPC-1	NEC
	IC1	Constant voltage	1	μPC14305H	NEC
	IC3,IC4	TTL	2	SN7406	TI
Transistor	TR1-TR7	Power darlington	7	2SD558	NEC
	TR8		1	2SC945 (Q)	NEC
	TR9		1	2SC2001 (L)	NEC
	TR10		1	2SB564 (L)	NEC
	TR11		1	2SC1449 (L)	NEC
	TR12,TR13		2	2SA733 (Q)	NEC
Diode	D1-D7,D15		8	F-14A	NEC
	D8-D14	Zenor	7	RD-6.2F	NEC
				(watts) (ohms)	
Resistor	R1	solid	1	2W ±10%, 22 ohms	
	R2,R3,R5,R7 R8,R13-R16 R18-R20,R22	carbon	13	1/4W =5%, 1K	
	R4,R6,R11,R28	carbon	4	1/4W ±5%, 120K	
	R9	carbon	1	1/4W ±5%, 4.7K	
	R10	carbon	1	1/4W ±5%, 22K	
	R12,R23	carbon	2	1/4W ±5%, 10K	
	R21,R24	carbon	2	1/4W ±5%, 2.2K	
	R25	carbon	1	1/4W ±5%, 470	
	R26	carbon	1	1/4W ±5%, 560	
	R27	carbon	1	1/4W ±5%, 5.6K	
Crystal	X-TAL	6 MHz	1	HC-18U	YAGUMO TSUSHIN
Condensor	C1,C4	Tantalum	2	3.3 μF, 16V	NEC
	C2,C11,C13	Ceramic	3	0.022 μF, 50V UBD10W223K	TAIYO YUDEN
	C3,C10,C12	Tantalum	3	6.8 μF CS99E1D6R8M	NEC
	C5	Aluminum	1	47 μF, 10V 10ELA47T	NICHICON
	C6,C7	Ceramic	2	20pF DT200YB20PF	NICHICON
	C8,C9	Ceramic	2	0.1 μF, 12V BD10X104X	TAIYO YUDEN
Switch	SW	Push Button	1	AKC8N	ALPS ELECTRIC
Connector	CN1		1	5049-15A	MOLEX
	CN2		1	5049-10A	MOLEX
	CN3		1	L25-014	UNION MACHINERY
	CN4		1	L25-010	UNION MACHINERY
Cable		with connectors for CN1 and CN2	1 set		

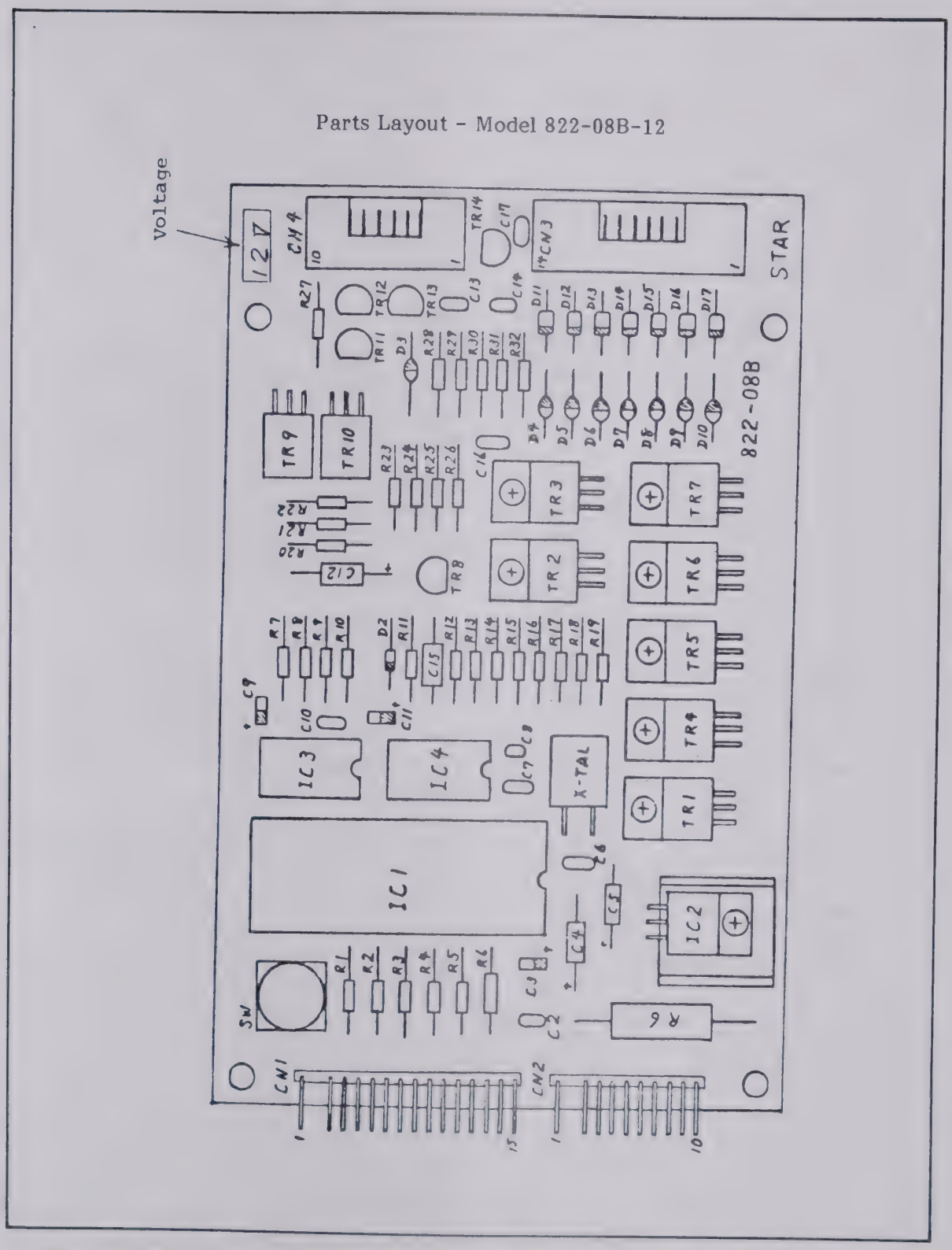


Figure 4.26. Control/Drive Card for Dot Matrix Printer Model 822-08B, Component Location

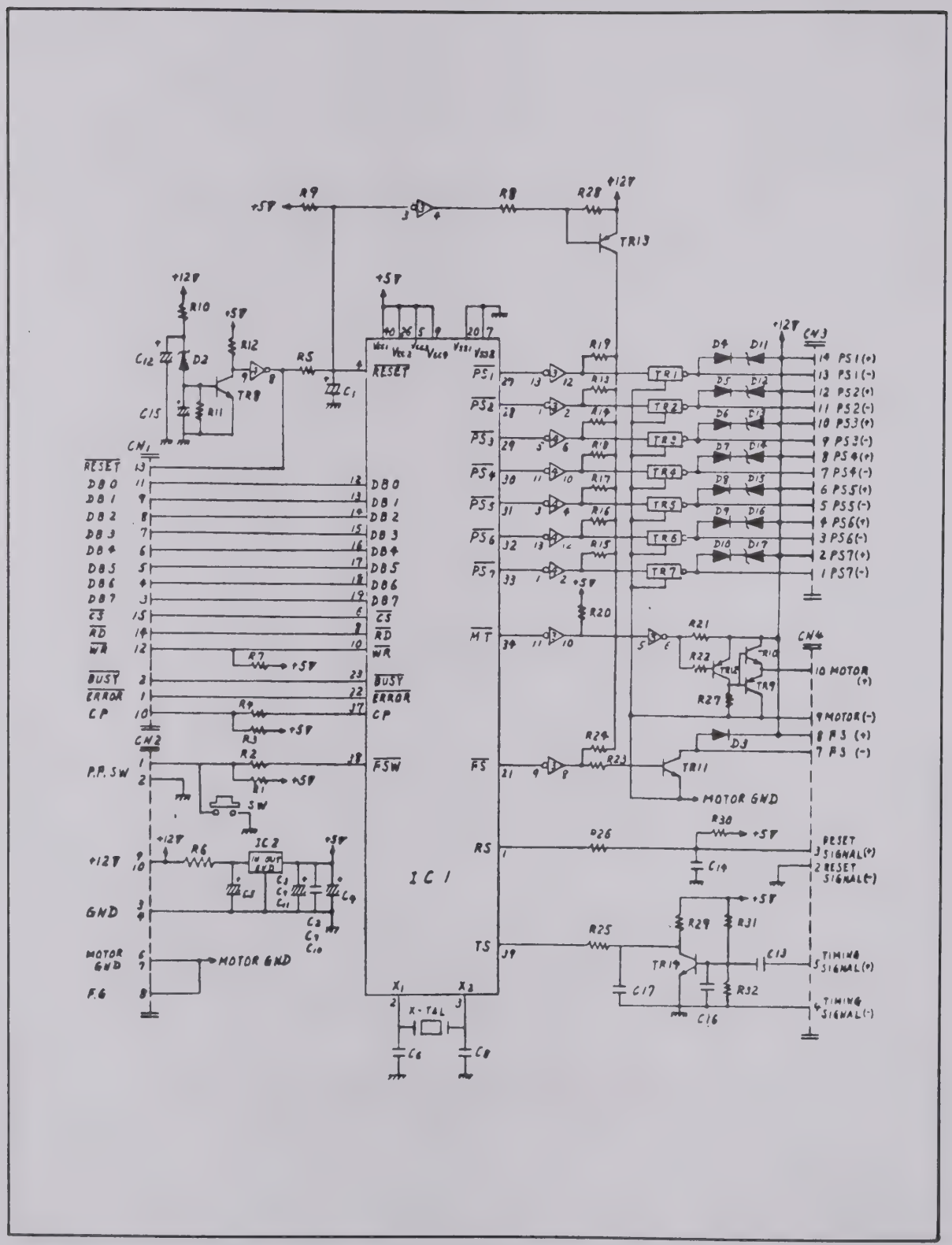


Figure 4.27. Control/Drive Card for Dot Matrix Model 822-08B, Schematic Diagram

Parts List of Control/Drive Card for Model 822-08B

Type of Component	Star Part Number	Description	Qty.	Mfr's Number or Characteristics	Supplier
P.C. Board		Two-sided	1	822-08B	
IC	IC1	LSI, custom	1	DPC-1	NEC
	IC2	Constant voltage	1	μPC14305H	NEC
	IC3,IC4	TTL	2	SN7406	TI
Transistor	TR1-TR7	Power darlington	7	2SD686	TOSHIBA
	TR8,TR14		2	2SC945 (Q)	NEC
	TR9		1	MJE700	MOTOROLA
	TR10		1	2SC1449 (L)	NEC
	TR11		1	2SC2120 (O)	TOSHIBA
	TR12,TR13		2	2SA733 (Q)	TOSHIBA
Diode	D2	Zener	1	HZ9C-2L	HITACHI
	D3-D10		8	F-14A	NEC
	D11-D17	Zener	7	RD-6.2F	NEC
				(watts) (ohms)	
Resistor	R1,R3,R7,R31	carbon	4	1/4W ±5%, 120K	
	R2,R4,R5,R23 R25,R26	carbon	6	1/4W ±5%, 1K	
	R6	carbon	1	2W ±5%, 22	
	R8	carbon	1	1/4W ±5%, 5.6K	
	R9	carbon	1	1/4W ±5%, 220K	
	R10,R11,R21 R29	carbon	4	1/4W ±5%, 10K	
	R12,R20,R30	carbon	3	1/4W ±5%, 4.7K	
	R13-R19,R22 R24,R27	carbon	10	1/4W ±5%, 2.2K	
	R28	carbon	1	1/4W ±5%, 560	
	R32	carbon	1	1/4W ±5%, 22K	
Crystal	X-TAL	6 MHz	1	HC-18U	YAGUMO TSUSHIN
Condensor	C1	Aluminum	1	3.3 μF, 50V	
				TY(MS) type	NEC
	C2,C7,C10	Ceramic	3	0.022 μF, 50V	
				UBD10W223K	TAIYO YUDEN
	C3,C9,C11	Tantalum	3	6.8 μF	
				CS99E1D6R8M	NEC
	C4	Aluminum	1	47 μF, 6.3V	
				TT(MS) type	SHIN'EI TSUSHIN
	C5,C15	Aluminum	2	1 μF, 50V	
				TT(MS) type	SHIN'EI TSUSHIN
	C6,C8	Ceramic	2	20pF	
				DT200YB20PF	NICHICON
	C12	Aluminum	1	10 μF, 35V	
				TT(MS) type	SHIN'EI TSUSHIN
	C13,C14	Ceramic	2	0.1 μF, 12V	
				BD10X104X	TAIYO YUDEN
Switch	SW	Push Button	1	AKC8N	ALPS ELECTRIC
Connector	CN1		1	5049-15A	MOLEX
	CN2		1	5049-10A	MOLEX
	CN3		1	L25-014	UNION MACHINERY
	CN4		1	L25-010	UNION MACHINERY
Screw & Nut		Screw	1	TR3-7	
		Screw	7	TR3-5	
		Nut	8	N-3	
Heat Sink		Aluminum plate	1		
Cable		with connectors for CN1 and CN2	1 set		

4.5 OPERATIONAL PROGRAMS

4.5.1 General

The operational program for the Model 4657B Error Rate Analyzer resides in 32K bytes of EPROM memory and uses 4K bytes of RAM. The Processor PWB (A1) provides sockets for five 2764-type EPROMs which represent 40K bytes of memory, and three 6116 which provides 6K bytes of RAM, 2K of which is battery backed-up. The program was written in a logical combination of FORTRAN and 8080 Assembly language. Also, the program was written in a highly modular form using structured programming techniques. Various routines and subroutines were connected through branch tables and linked using a linking loader. A floating point package tailored to this application provides the math capability required in normal BERTS operation.

4.5.2 Routine

The Model 4657B Analyzer is of a software intensive design. The error counting hardware provides status lines, million bit interrupts, and three "wrap-around" error counters for Bit, Parity, and Bipolar Violations. The program from these functions develops the Error Seconds, Total Errors, Average BER, and formats the displays and print-out messages. "Wrap-around" counter lengths are 15 bits for Bit Error, 8 bits for Parity Error, and 12 bits for Bipolar Violations.

The software services the million-bit interrupt every 22 milliseconds by reading the error counters and adding any increases to internal software accumulators. Each accumulator is 40 bits long. The length of a hardware "wrap-around" counter determines the maximum error rate that can be counted since each will be read every million bits. For Bit errors this is equal to $2^{15}/10^6$ (or BER = 3×10^{-2}), and for Bipolar Violations is equal to $2^{12}/10^6$ (or BER = 4×10^{-3}). Since there can be only 210 Parity errors per million bits, all Parity errors can be counted with an 8-bit hardware counter. The software counts ten interrupts to provide the latest BER on a 0.22-second update rate or 100 interrupts for a 2.2-second update.

To measure Error-Seconds, all errors are related to the 1.0-second interrupts from the Real-Time Clock in asynchronous error-second mode. In the synchronous error-second mode, an error-second is defined as beginning at the first error and ending one second later. Average BER is then calculated by counting million-bit interrupts during the length of the test and dividing total errors by total 1.0-second pulses. Because errors are counted over million-bit intervals and at 44.736 Mbps, there will not always be the same number of million-bit intervals in each 1.0-second short timed test. (The 1.0-second timed test is only an example of a back-to-back test with a compatible Model 4651B Error Rate Test Transmitter set for a high error rate.) The total errors will vary between two numbers from second to second corresponding to counting either 44 or 45 million-bit interrupts.

Since BER is computed on the number of million-bit interrupts, Average (AVG) BER will always be correct, TOTAL ERRORS will be correct, and ERROR-SECONDS will be correct to within the quantization interval. Quantitizing errors to million-bit intervals simplifies calculations for various displays. For example, the microprocessor cannot operate nor calculate on errors at 44 Mbps, but through the quantitizing process, data can be supplied to the microprocessor at a rate within its design parameters.

4.5.3 Memory and I/O Assignments

The operational program for the Model 4657B resides in EPROM address locations ØØØØH to 7FFFH. RAM is located in CØØØH to FFFFH. RAM address decoding is not unique, so each 2K of RAM appears over an entire 8K address block. The basic I/O assignments are listed in Table 4.1.

4.5.4 Hardware/Software Interfacing

There are six sources of interrupts to the microprocessor. They are identified as:

1. Million-bit interrupt

2. One-second pulse from the Real-Time Clock
3. One-tenth second pulse from the Real-Time Clock
4. Burst interrupt
5. Power failure
6. Option installed (either RS-232 or IEEE-488)

When interrupted, the software first checks if the "million-bit interrupt" is active by testing for a Ø in bit 4 of Address E4H. This interrupt will be reset by Address EØH. The next check is made of the 1.0-second pulse interrupt by testing for a Ø in bit 7 of Address 4ØH, which will be reset by Address 41H. The "option interrupt" (if installed) will be processed by inputting or outputting data as determined by an interrupt register provided in the Controller circuit of the installed option PWB.

4.5.5 Printer Driver

The local Printer (Option Model 4650) receives data from a parallel I/O port (8255) on the Processor PWB (A1). The data is output as ASCII format with software generated READ, WRITE, and STROBE LINES. Input data consists of printer OFF (or disconnected) and Out-of-Paper from the paper sense switch. Messages are formatted identical to operation with the RS-232C Interface Option (357190) PWB; but the data is separately buffered so that the difference in speed between a local Printer and an RS-232C Interface output (for example) will not slow down the faster device.

CHAPTER 5
MAINTENANCE

5.1 GENERAL

Due to the reliability and nature of the Model 4657B Analyzer, periodic maintenance is not necessary beyond keeping the air intake filters clean. It is recommended, however, that units be inspected and calibrated yearly by Scientific-Atlanta personnel or representatives. This action will insure that the equipment will meet all published specifications and provide the user with trouble free, accurate performance. The nearest Scientific-Atlanta Regional Service Center can arrange for such factory calibration. These centers are listed on the last page of this chapter.

WARNING

THIS UNIT CONTAINS HAZARDOUS VOLTAGES WHEN POWER IS ON. READ WARNINGS ON PAGE 5-4 - BEFORE PROCEEDING.

5.2 TROUBLESHOOTING - INTRODUCTION

The intent of this section is to enable the technician to repair equipment out of warranty by locating and identifying defective printed circuit boards. Once the defective printed circuit board has been isolated, either a pre-tested replacement may be obtained from Scientific-Atlanta or further troubleshooting may be performed. It is suggested that prior to troubleshooting within a printed circuit board, the technician review thoroughly the applicable section in the Theory of Operation, Chapter 4, and the appropriate schematic.

Signals received by and generated internally to the Model 4657B Analyzer are processed centrally by the microcomputer on the Processor PWB (A1) which controls functions such as routing and distribution through other various printed circuit boards. While it is not possible to describe all the failure modes associated with a Model 4657B Analyzer operating into a system, there are basic steps which can be performed to locate and isolate malfunctions. This chapter is arranged to provide a logical sequence of basic procedures to isolate a fault within a Model 4657B Analyzer.

The following tests should be performed and verified using a Hewlett-Packard Model 3465A Digital Volt Meter (DVM) for voltage and resistance measurements and a Tektronix Model 475 Oscilloscope to observe waveform patterns. The test equipment should be calibrated and operating within its specified accuracy. Equivalent or better test equipment may be substituted when required.

5.3 TROUBLESHOOTING THE MODEL 4657B ANALYZER

Figure 5.1 is a flow chart of step-test sequences to isolate a malfunction within a Model 4657B Analyzer. Obviously the malfunction symptoms will dictate which steps should be performed and which steps can be set aside as secondary or to be performed if the initial steps fail to isolate the malfunction. If a malfunction is isolated to a printed circuit board which can be field calibrated (i.e., a power supply PWB), perform the entire calibration procedure before attempting to verify normal operation. If a malfunction is isolated to a source that is not field repairable (i.e., Processor PWB (A1) et. al.) and/or does not respond to normal repair procedures and/or calibration, then the suspect source should be replaced by an identical item purchased from Scientific-Atlanta.

5.3.1 Model 4657B Analyzer Visual Inspection

A visual inspection check of a Model 4657B Analyzer should consist of the following steps as a minimum:

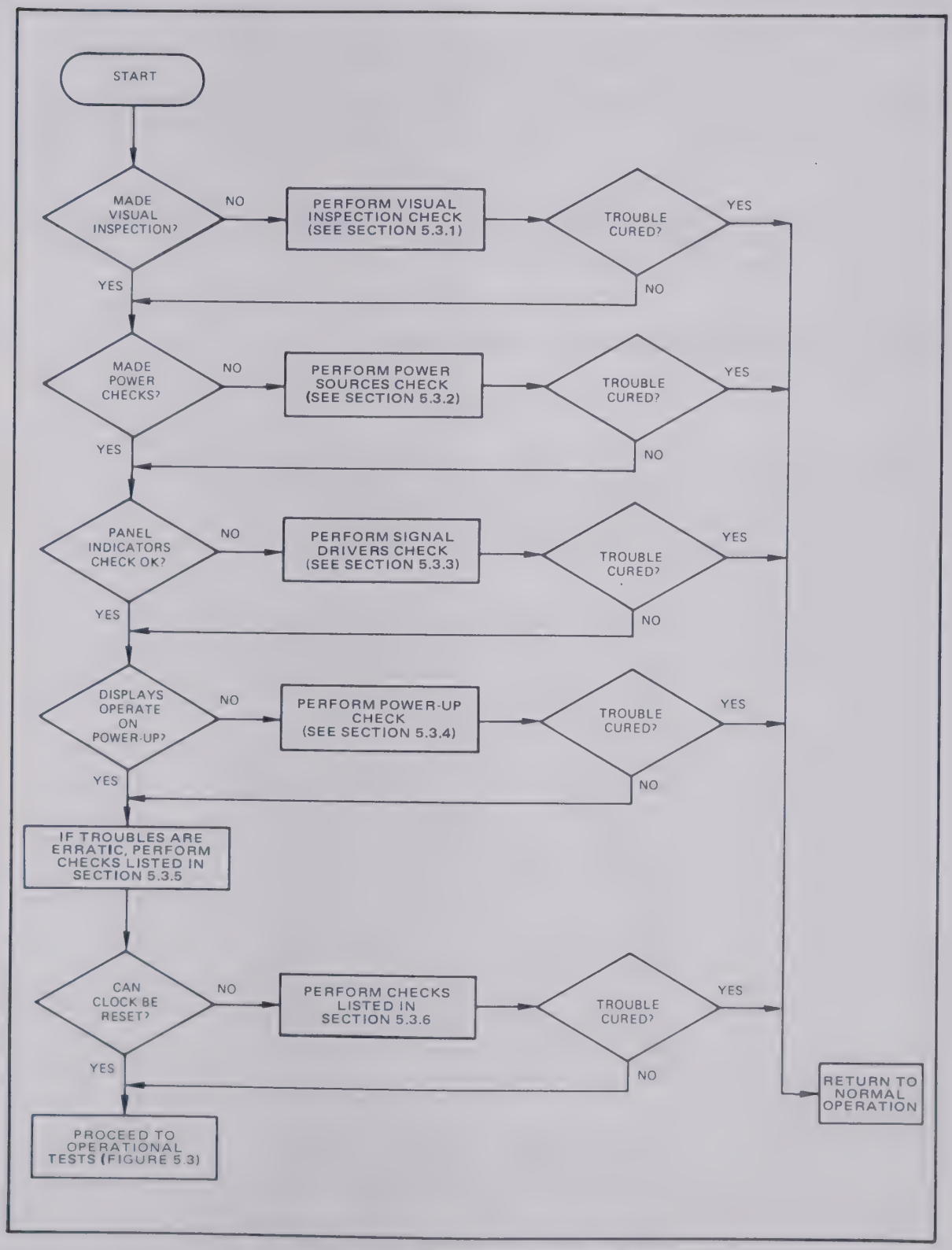


Figure 5.1. Troubleshooting Flow Chart

1. Check all PWBs for proper installation.

2. Check for broken wires. This includes all PWB connections, coax and flat cables, and panel connections. Examine PWB components for obvious defects (i.e., discoloration, bulging, overheating, etc.).

3. Check that all cables are properly installed. Also inspect for bent pins, discolored or deformed connector shells, frayed or punctured insulation, etc.

5.3.2 Model 4657B Analyzer Power Sources

WARNING

THIS POWER SUPPLY CONTAINS HAZARDOUS VOLTAGES WHEN ENERGIZED. TO AVOID THE POSSIBILITY OF INJURY OR DEATH, THE FOLLOWING PRECAUTIONS MUST BE FOLLOWED BEFORE THE INSTRUMENT IS SWITCHED ON:

1. **THE PROTECTION PROVIDED BY GROUNDING THE INSTRUMENT CABINET MAY BE LOST IF ANY POWER CORD OTHER THAN THE THREE-PRONGED TYPE SUPPLIED IS USED TO COUPLE THE AC LINE VOLTAGE TO THE INSTRUMENT.**

2. **IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTO-TRANSFORMER TO REDUCE OR INCREASE THE LINE VOLTAGE, MAKE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.**

3. **THE POWER CORD SHALL ONLY BE INSERTED INTO A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH GROUND. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD WITHOUT A PROTECTIVE GROUND.**

4. **THE SERVICE INFORMATION PROVIDED IN THIS MANUAL IS OFTEN USED WITH POWER ON AND PROTECTIVE COVERS REMOVED FROM THE INSTRUMENT. THE VOLTAGE AVAILABLE ON THE POWER SUPPLY AND REAR PANEL MAY RESULT IN PERSONAL INJURY IF CONTACTED.**

5. **CAPACITORS ON THE POWER SUPPLY MAY STILL BE CHARGED EVEN IF THE INSTRUMENT HAS BEEN DISCONNECTED FROM THE POWER SOURCE.**

6. **ANY ADJUSTMENT OR REPAIR OF THE INSTRUMENT WITH POWER ON SHOULD BE PERFORMED ONLY BY A SKILLED PERSON WHO IS AWARE OF THE HAZARD INVOLVED.**

A check of the Model 4657B Analyzer power sources should be verified using the DVM and the following tests:

1. Check the ac source (if used). Determine if the ac source is controlled by a switch. Check the source ac at the chassis connector. Verify that the voltage select PWB next to the ac fuse is properly installed. (See Figure 5.2.) Check the ac fuse for continuity. Check ac distribution using schematic diagrams in Chapter 7.

2. Check the dc input source (if used). Determine if the dc source is connected using the correct polarity. Check the dc fuses on the Power Supply PWB (A3) for continuity. Check the input dc source distribution using schematic diagrams in Chapter 7.

3. Check the operation of the Power Supply PWB (A3). Verify the following requirements. If the requirements are not met, troubleshoot and repair the power supply PWB.

   On Processor PWB A1, measure from P2-14 to P2-1.

   Requirement: -5.2 (±0.3)V dc

   On PWB A1, measure from P2-7 to P2-1.

   Requirement: +5.0 (±0.25)V dc.

   On PWB A1, measure from P2-15 to P2-1.

   Requirement: +12 (±0.4)V dc.

   On PWB A1, measure from P2-20 to P2-1.

   Requirement: -12 (±0.4)V dc.

   On ECL Logic PWB A2, measure from P1-30 to P1-50.

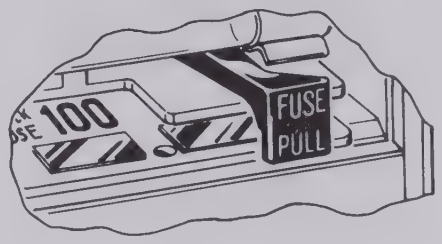
   Requirement: -5.2 (±0.3)V dc.

   On PWB A2, measure from P1-1 to P1-50.

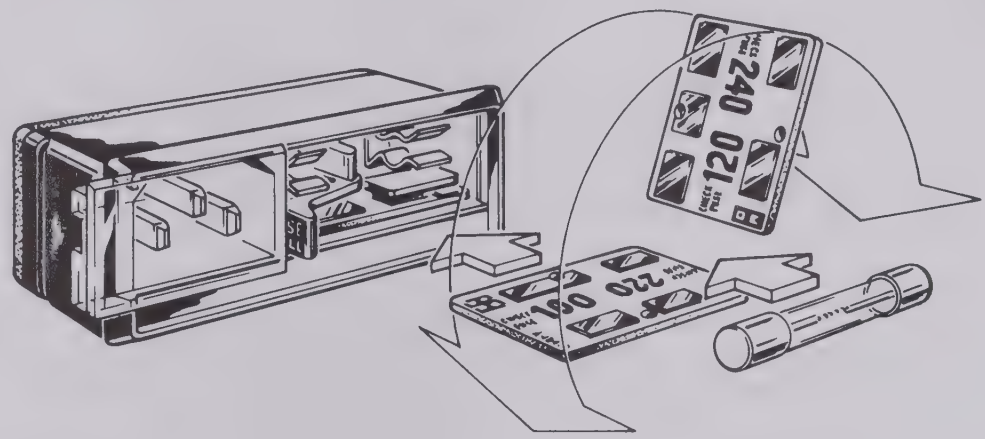
   Requirement: +5.0 (±0.25)V dc.

   On Clock Recovery PWB A4, measure from P1-16 to P1-8.

   Requirement: +12 (±0.4)V dc.



Operating voltage is shown through the sliding plastic window.



HOW TO SELECT OPERATING VOLTAGE

1. Remove the ac power cord connector.
2. Slide the plastic window to the left.
3. Carefully operate FUSE PULL tab to the left.
4. Carefully remove both the fuse and printed circuit board. A small hole is provided to accommodate a wire pull if necessary.
5. Correctly orient the printed circuit board so the desired voltage is located on the top left side.
6. Carefully return the printed circuit board to the original location. Be sure it is securely seated.
7. Return FUSE PULL tab to the normal position.
8. Replace the original fuse with one selected for correct fuse value.

Illustrations courtesy of Corcom Corp., Chicago, Ill.

Figure 5.2. Selecting the Proper Operating Voltage

On PWB A4, measure from P1-20 to P1-8.

Requirement: -12 (±0.4)V dc.

5.3.3 Model 4657B Analyzer Panel Indicators

If the front panel indicators are not operating properly, perform the following checks:

1. Check for proper installation of the Front Panel PWB (A5) to the Processor PWB (A1), the ECL Logic PWB (A2), and the Power Supply (A3). Observe for bent connector pins and/or misalignment of the PWB that could allow a short circuit or other types of signal malfunctions.

2. Check for a binary counting sequence on the Scan Lines (SLØ-SL3) of the 8279 (A1-U39). If the lines are not active, check for bent pins and the presence of +5V, GND, and the ϕ2 CPU clock at the IC.

3. If the lines SLØ-SL3 are active, check the outputs of the display decoders U44 and U46, and the keyboard decoder U49 for pulses.

4. Verify that data pulses are present on the outputs of U40.

5. Verify that the signals are reaching the segment drivers (U1 and U2) and the digit drivers (U3 and U6) on the front panel.

6. Check the discrete LED latches U50 and U52 on the Processor PWB (A1) for the presence of $\overline{IOW}$ and chip select pulses.

5.3.4 Model 4657B Analyzer Power-Up Checks

With proper ac/dc source input voltage applied, and with the Power switch ON, observe the following steps:

1. "OPt" will appear in the TIME display indicating that Options are being searched for. Routines for options found will be linked into the program.

2. Either an "A" or an "S" will appear in the fourth position of the TIME display indicating the selection of either Asynchronous or Synchronous Error Seconds. (See Operator's manual.)

3. A Hexadecimal number will appear in the fifth position of the TIME display for each option found indicating the 8K boundary address at which the Option Routines reside.

4. Each option will display its own Sign-on message in the MEASUREMENT display. If a remote interface board is installed in the unit, the IEEE-488 bus address or RS-232 baud rate will be displayed in the sixth and seventh position of the TIME display. (See the appropriate option section of the Operator's Manual.)

5. A LAMP TEST will be executed during which the RESET switch can be pressed if a PRISTINE RESET is desired.

6. Operation will resume in the state the Model 4657B Analyzer was in at time of POWER-DOWN (or in the default state if a PRISTINE RESET was performed) with the RUN or STOP LED flashing to indicate POWER LOSS. The non-volatile RAM in the Model 4657B Analyzer enables the unit to "remember" its state prior to power down.

The displays will not illuminate unless there is a proper ac/dc source input applied. The battery backup provides the Real-Time Clock and N.V. RAM with sufficient power to keep current time, date, and setup information only. If the TIME display is erratic, the battery may be fully discharged. The battery will normally recharge while the equipment is provided external source power. A running TIME display should be observed if the battery voltage is over 3.0V dc, and battery voltage could measure approximately 4.0V dc while being charged. If the charging voltage does not exceed 3.0V dc, the battery should be replaced. It should be noted that the Model 4657B Analyzer can operate without the battery, but each Power-Up sequence will require the TIME display to be reset and test setups will not be saved.

5.3.5 Model 4657B Analyzer Self-Test

The Model 4657B Error Rate Analyzer has the capability to test some of its own hardware. The attempt to enter a negative value for MONTH-DAY while in the STOP mode puts the Model 4657B Analyzer into a nondestructive (no information is lost) SELF-TEST. The simplest way to access this mode is to press the ELAPSED (±) switch and then the MONTH-DAY switch with the SHIFT switch held in. The message "tESt" will then appear in the TIME display. The Real-Time Clock will be tested, RAM (Random Access Read/Write Memory) and ROM

(Read Only Memory) will then be tested and the results will be shown in the MEASUREMENT display. Next, the Scientific-Atlanta program firmware number and then the revision level will be displayed, the audible alarm will be sounded, and a LAMP TEST will be initiated. Note that the RESET button may be pressed during this LAMP TEST if a PRISTINE RESET is desired. Also note the following:

1. The SELF-TEST displays the location of the first RAM and ROM IC in which it detects a failure only.

2. A failure does not necessarily indicate a defective IC. The failure could be due to solder bridges, or an improperly seated EPROM or RAM.

5.3.6 Model 4657B Analyzer Real-Time Clock Reset

The Model 4657B Analyzer Real-Time Clock display is a prominent feature and often is the first indication of equipment malfunction. The following tests should be performed if resetting the TIME display presents a problem.

1. If the time and date are inaccurate on power-up, it is possible that the battery has discharged. Check it for about +3.75V dc with external power off and replace if necessary.

2. Check the Real-Time Clock oscillator U28 on the Processor PWB (A1). Pin 9 should have a 32768 Hz squarewave and this signal should reach U27-pin 10.

5.4 MODEL 4657B ANALYZER OPERATIONAL TESTS

There will be times when the fastest method of identifying Model 4657B Analyzer malfunctions and the isolation of a fault is to inject a valid data signal and observe the resulting indications. The sequence as shown in Figure 5.3 and used in the following procedures provides interpretation of some common failures with suggested diagnostic steps to rapidly isolate a malfunction. The term "valid DS3 signal" used in the following procedures should be understood as a signal such as generated and output from a Model 4651B Bit Error Rate Test Transmitter known to be operating within its

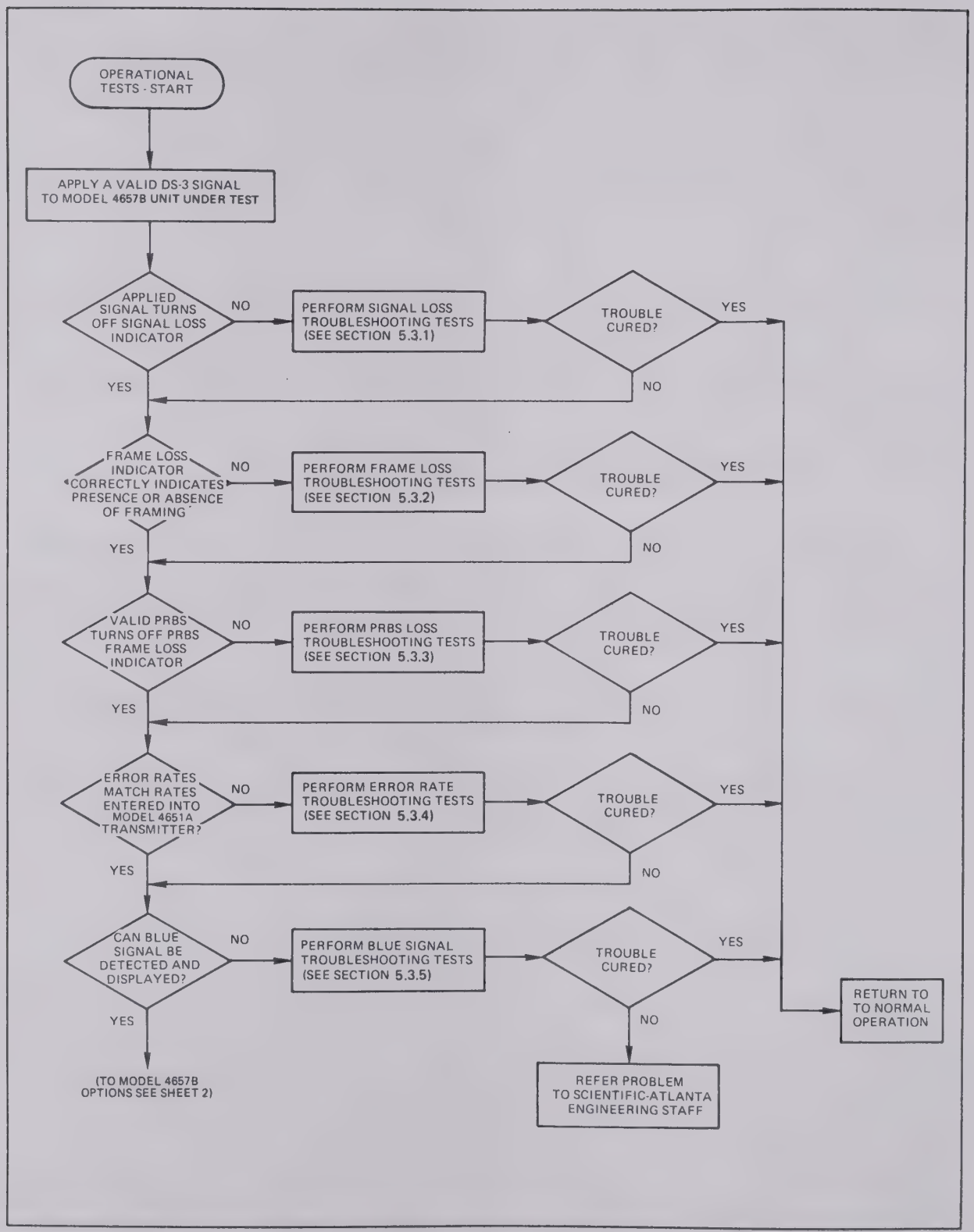


Figure 5.3. Troubleshooting Flow Chart Using Operational Tests (Sheet 1 of 2)

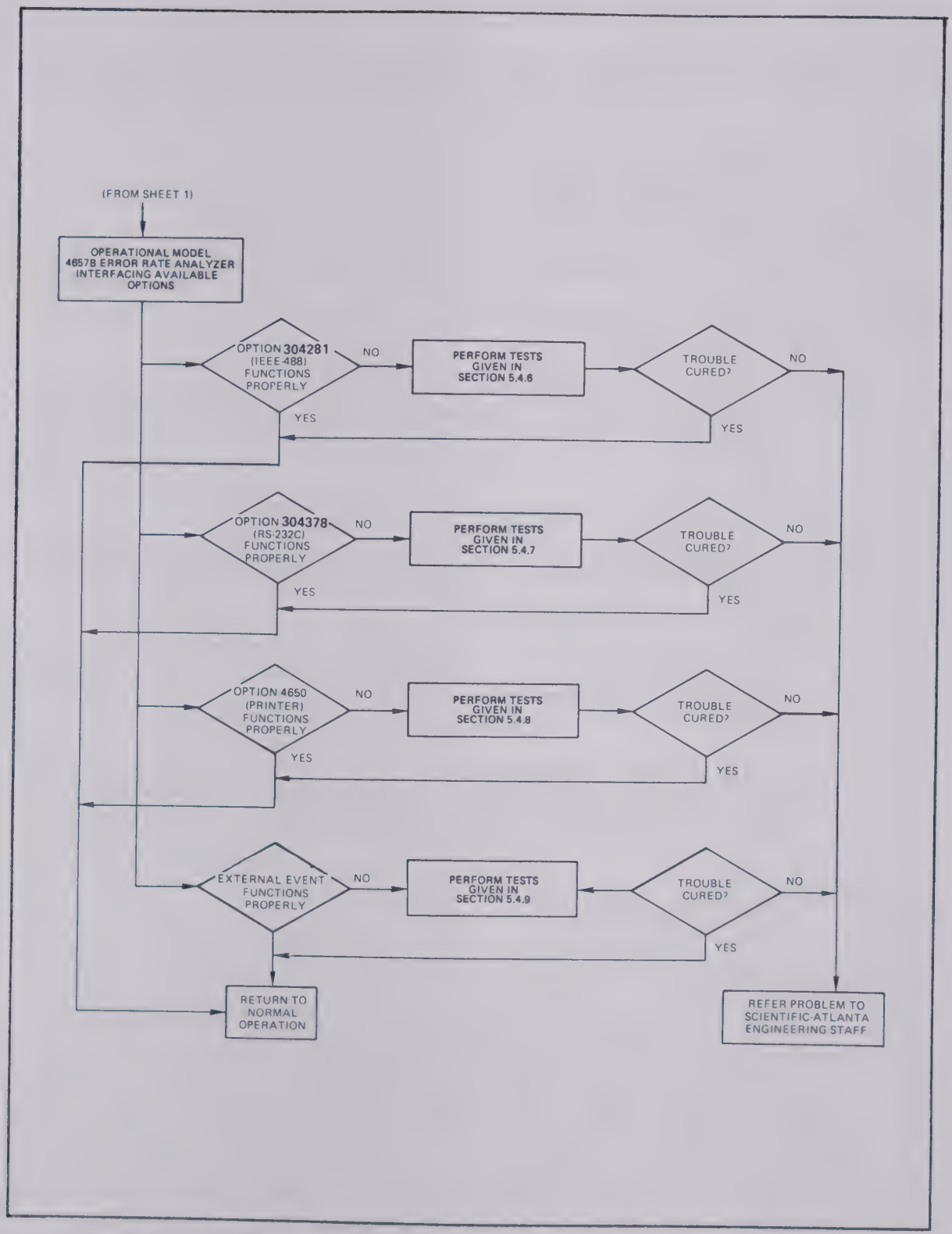


Figure 5.3. Troubleshooting Flow Chart Using Operational Tests (Sheet 2 of 2)

specified range and accuracy. An equivalent signal may be substituted if available.

5.4.1 Signal Loss Failure

If the Model 4657B Analyzer indicates normal operation (i.e., no faults as identified in Section 5.3) but applying a valid DS3 signal input causes the SIGNAL LOSS indicator to illuminate, perform the following tests:

1. Using a valid DS3 input signal, verify operation of the AGC circuits on the 44.7 MHz Clock Recovery PWB (A4). Observe the signal at test point TP7 for a constant peak amplitude while alternately operating the LO/HI and DSX-3 switches on the front panel.

2. Using either a DS3 or a NRZ input signal, check the signal at U10, pin 15 on the 44.7 MHz Clock Recovery PWB (A4). It should be an ECL low when a signal is applied and a high with no signal.

3. Observe the operation of U10-pins 7 and 9 on the 44.7 MHz Clock Recovery PWB (A4). Pin 7 should be an ECL high when a bipolar signal is applied and pin 9 should be high whan an NRZ signal is applied.

4. Apply a valid DS3 signal (or an NRZ signal) and signal trace (using schematics in Chapter 7) circuit paths from U10-pin 15 on A4, through translator U58D on the ECL Logic PWB (A2) and on to latch U23A on the Processor PWB (A1).

5.4.2 Frame Loss Failure

If normal operation of a Model 4657B Analyzer is indicated as in Section 5.3, but applying a Framed DS3 signal input does not extinguish the FRAME LOSS indicator, perform the following tests. Because of the complex circuitry required to recover and acknowledge the Framing signals, a malfunction of this nature is easier to troubleshoot when a second Model 4657B Analyzer (known to be functioning properly) is available. The following tests are started with two preliminary approaches to isolate a malfunction. Test 1 can be used if a good second Model 4657B Analyzer is available; or Test 2 should be used if a second analyzer is not available. Perform either Test 1 or Test 2, whichever

meets your requirements. If the malfunction continues to exist, then proceed with Test 3. Be sure to observe ALL applicable Notes.

Notes:

1. If NRZ inputs are used in place of a bipolar DS3 signal, check the phasing of clock and data signals before testing. (Reference the Figure entitled "Clock and Data Timing Relationship for NRZ Input Signals" in the 4657B Analyzer Operator's Manual.)

2. If FRAMING cannot be acquired, observe if the Model 4657B Analyzer under test is counting Bipolar Violations for DS3 input. If Bipolar Violations are occuring, the indication is either a bad input or the improper extraction of data by circuits on the 44.7 MHz Clock Recovery PWB (A4).

TEST 1. Isolating a Frame Loss Malfunction Using a Second 4657B Analyzer

1. Verify that the valid DS3 signal has proper framing.

2. Substitute individual PWBs from the trouble-free Model 4657B Analyzer, one by one in the following sequence and observe after each substitution if the malfunction continues to occur. This substitution routine may provide some isolation of the malfunction.

   - 44.7 MHz Clock Recovery PWB (A4)
   - ECL Logic PWB (A2)
   - Processor PWB (A1)

3. If trouble continues, go to Test 3.

TEST 2. Isolating a Frame Loss Malfunction Without a Second 4657B Analyzer

1. On the Clock Recovery PWB (A4), verify that P2 is installed on pins 1 and 2 of J2 and that P4 is installed on pins 1 and 2 of J5.

2. Verify operation of the 44.7 MHz Clock Recovery PWB (A4) by monitoring the four data outputs at connector P1, pins 5, 6, 9, and 10, while the Model 4651B Bit Error Rate Test Transmitter is providing an input signal of ALL ONES or the BLUE signal. This will provide a repeating pattern on each data output line.

3. Verify the operation of the B3ZS Decoder and Blue Signal Detector section of the ECL Logic PWB (A2) by monitoring the data output signals at Flip-Flop U5B-pin 15, while the Model 4651B Bit Error Rate Test Transmitter is providing an input signal of ALL ONES, then ALL ZEROS, then the BLUE signal. Except for framing bits, the monitored data line should match

the incoming data signal by remaining high, low, or displaying the BLUE signal squarewave.

4. If trouble continues, go to Test 3.

TEST 3. Isolating a Frame Loss Malfunction: All Analyzers

1. If a FRAME malfunction has not been isolated using either TEST 1 or TEST 2, then verify that the F-Frame signal is in sync (TTL-High) at U58A-pin 4, and that this signal reaches U23-pin 6 on A1. Similarly, verify (1) the Gapped Clock signal at U43-pin 9; (2) the M-Clock signal at TP17; and (3) the F_1B signal (first F-bit of sequence) at TP16.

2. Verify the M-Frame function by observing an in-sync signal (TTL-High) at U55A-pin 4 and that this signal reaches U23-pin 11 on A1.

3. Thoroughly review the detailed circuit descriptions before troubleshooting applicable PWBs.

Note: Heat sensitive problems in ECL logic circuit components can usually be isolated to an individual component using a freeze spray.

5.4.3 PRBS Loss Failure

If normal operation of a Model 4657B Analyzer is indicated as in Section 5.3 but applying a PRBS DS3 signal input causes the PRBS FRAME panel indicator to illuminate, perform the following tests. It is presumed that SIGNAL LOSS and FRAME LOSS indicators are extinguished indicating normal operation of these functions.

1. Verify that both Clock and Data input signals are being applied to the Pseudo Random Bit Sequence Generator section of the ECL Logic PWB (A2).

2. Check the signal functions associated with component A2U15 and verify the signal on the PRBS Sync line at U25-pin 6.

3. Signal trace the signals from the PRBS Sync line (A2U25-6) to the latch on the Processor PWB (A1U23-15). This line should be low to indicate PRBS in sync.

5.4.4 Error Rate Mismatch

Normally, a Model 4657B Analyzer faithfully tracks the generated error rate programmed into a Model 4651B Error Rate Test Transmitter output signal. When a malfunction of this nature occurs, the trouble should be isolated using the following tests.

Note: Be aware of the transmitter analyzer relationships. For example, during normal operation, a 10^{-3} BIT ERROR RATE (BER) selected on a Model 4651B Error Rate Test Transmitter will be displayed as "1.60 x 10^{-4}" Parity Error on the Model 4657B Analyzer. Also, when synchronous Error-Seconds are selected, the Error-Seconds display may not increment smoothly, due to the lack of synchronization between the Error-Seconds and the one-second display update rate. Other "Errors" are directly displayed as programmed.

1. Configure a Model 4651B Error Rate Test Transmitter to output ALL ONES DATA with 10^{-3} BIT ERROR RATE. At the analyzer under test, verify the presence of 11 ns pulses with a 22µs period at A2U26-9 and 15. If pulses cannot be verified, troubleshoot and repair the ECL Logic PWB (A2).

2. Signal trace errors through translator U59A and on to counters U83, U84, U86, and U95 on the Processor PWB (A1). Verify operation of the Million Bit Divider by observing that the output pulse at U63-pin 5 on the ECL Logic PWB has a 22ms period, and that it reaches the circuits on the Processor PWB (A1 - U85 and U87 pins 11).

3. Signal trace Parity Errors detected in the M-Frame Synchronizer circuitry (A2U50-15 and 14) to the Parity Counters (A1U60 and U61). Verify the presence of the Million Bit Strobe pulse at A1U65-pin 11.

4. Signal trace Bipolar Violation from the B3ZS Decoder and Blue Signal circuitry (A2U5-2 and 3) to the BPV Counters A1U62, A1U63, and A1U64. Verify the presence of the Million Bit Strobe pulse at A1U66, pin 11 and A1U67, pin 11.

5.4.5 Blue Signal Detection Malfunction

If a Model 4657B Analyzer fails to provide the BLUE signal display when the associated Model 4651B Error Rate Test Transmitter is properly configured (i.e., both OUTPUT switches, ALL ONES and PSEUDO RANDOM DATA, operated), the malfunction should be rapidly isolated using the schematics in Chapter 7 and the following tests:

1. Make sure the unit is in RUN mode displaying BIT error data.
2. Observe and verify the Blue Signal Detection circuit operation on the ECL Logic PWB (A2).
3. Observe and verify the BLUE signal line reaches U72-pin 11 on the Processor PWB (A1).

5.4.6 Option IEEE-488 (304281) Malfunction

If difficulties are encountered, perform the following tests on the unit:

1. Refer to the Operator's Manual to verify or reset Address and talk-only switches.
2. Verify that the IEEE-488 PWB is properly installed in connector J6 of the Processor PWB (A1), and that the jumper is installed on J3 on the IEEE-488 PWB.

5.4.7 Option RS-232 (304378) Malfunction

If difficulties are encountered, perform the following tests on the unit:

1. Refer to the Operator's Manual to verify or reset the Baud Rate switches and the DCE/DTE and SGL/DSY jumpers.
2. Verify the RS-232 PWB is properly installed in connector J6 of the Processor PWB (A1).

5.4.8 Option Printer Model 4650 Malfunction

If difficulties are encountered with Model 4650, the Local Printer, perform the following tests on the unit. Note that the printer mechanism and Control/Drive Card are purchased items and available documentation has been included in Chapter 4.

1. Refer to the Operator's Manual and cause the Local Printer to perform a Self-Test.

2. Check for a marginal or bad component on the Local Printer I/O Interface PWB (A2). See Chapter 7 for the schematic diagram.

5.4.9 External Event Monitor Malfunction

If difficulties are encountered, perform the following tests on the unit:

1. Verify that input voltages appear at the J5 connector on the Processor PWB (A1).

2. Verify that each integrated circuit has power and ground on the appropriate pins.

3. Verify that pulses are present at U76 pins 13 and 14 and at U78 pin 3.

4. Verify that Q8 and Q9 turn on when they are selected.

5. If calibration of the front panel display is necessary, first make sure that a calibrated DVM is available. Then connect BOTH 4657 DC voltage inputs to any DC Voltage source. Measuring this voltage at the source with the DVM, adjust R52 such that the two input voltages on the front panel agree with the DVM (or that any error is split between the two inputs).

6. Verify that U82, pins 17 and 18, toggle to reflect openings and closures of the two DRY CONTACT inputs.

7. A "+99.98" or a "-99.98" indicates a failure of the A-to-D circuitry.

5.5 CALIBRATION

The following procedures describe adjustments which can be accomplished under normal conditions in a general electronic repair center. Otherwise, there are six calibration adjustments for the Model 4657B Analyzer.

5.5.1 Test Equipment

The test equipment or its equivalent listed in Table 5.1 is required to perform the tests in this procedure. All test equipment must be calibrated and operating within is specified accuracy.

Table 5.1
Test Equipment

Description	Model	QTY	Manufacturer
DVM	3465A	1	Hewlett-Packard
Oscilloscope	475	1	Tektronix
Frequency/Period Counter	5315A	1	Hewlett-Packard
DC Supply, 0-60V, 9A	DCR 60-9B	1	Sorenson
IF Sweeper	1700	1	General Radio
RF Network Analyzer	1710	1	General Radio
75 Ohm Termination	011055	2	Tektronix
Probe, FET	P6201	2	Tektronix
Probe, 1MΩ	P6106	2	Tektronix

5.5.2 Model 4657B Analyzer Calibration

5.5.2.1 4.7 MHz Clock Recovery Adjust

AGC Calibrate. Place the unit bottom side up to expose the Clock Recovery PWB. Apply a high level DS3 signal from a Model 4651, Model 4651A, or Model 4651B Transmitter. Set the data pattern for all ONES unframed. Monitor TP-7 with the oscilloscope using a low capacitance FET probe set for internal termination. Adjust R42 until a 1V (±0.1) swing is obtained in both + and - directions.

Phase-Lock Loop. Place P2 on pins 2 and 3 of J2. Place P4 on pins 2 and 3 of J5. Connect the Frequency Counter to TP-5. Disconnect the input signal. Adjust R68 until the frequency reads 44.736 ±.010 MHz.

Connect a DVM to U9, pin 3. Adjust R102 until the dc voltage reads -1.30 ±0.01 volts. Reconnect the input signal.

Select framed PRBS signal. Enable the phase-lock loop (PLL) by moving P2 to pins 1 and 2 of J2. The unit should acquire FRAME and PRBS sync and not count errors. If the unit does not acquire FRAME and PRBS synch, adjust R102 slowly until it does. Disable the PLL by moving P2 back to pins 2 and 3 of J2. The unit will lose lock. Enable the injection lock circuit by placing P4 on pins 1 and 2 of J5. The unit should acquire FRAME and PRBS sync and not count errors.

Connect one scope probe to TP5 (clock) and another on TP8 (data). Observe the two waveforms on the scope triggering on the data. Select unframed, all ones data. Note the phase relation between the rising edge of the clock and the data; the rising edge should be near the center of the data period. Now enable the phase lock (P2 to J2-1 and 2) and disable the injection lock (P4 to J5-2 and 3). Adjust R102 until the phasing of the clock and data are as close as possible to that observed with the injection lock enabled.

NOTE

After this adjustment is made the PLL may not be able to acquire lock on its own since its capture range is limited.

5.5.2.2 NRZ Bipolar Bias Adjust

Remove the Clock Recovery PWB to allow access to the ECL PWB. Use the DVM and adjust R24 until U6 pin 11 measures -0.25 (±0.010)V dc with respect to U6 pin 10.

5.5.2.3 Real-Time Clock Calibrate

Setting the Clock Frequency. Apply ac power and monitor U28-3 on the Processor PWB (A1) using the Frequency/Period Counter. Set the Counter to measure a period with 1µs resolution. Adjust trimmer C8 to set the timer period to 500,000(±3)µs.

5.5.2.4 External Event Monitor Calibration

1. Disconnect any input signal connected to the External Event Monitor input connector.
2. Select IN1 with the DC MON switch on the front panel.
3. Adjust R72 on Processor PWB (A1) for a reading of 0.00 ±0.01V dc on the MEASUREMENT display.
4. Apply 10.00V dc, from a DC Supply, to DVC1, and DVC2 pins on External Event Monitor input connector (See Figure 3.9 in the Operators Manual).
5. Adjust R52 on Processor PWB (A1) until both IN1 and IN2 displays indicate as close to 10.00V dc as possible (split any error between the two displays).
6. Disconect DC Supply.

5.5.2.5 Bipolar Bias Adjustment

1. With unit power off, remove the Clock Recovery PWB (A4) from the unit.

2. On the ECL Logic PWB (A2) connect a DVM between U6 pin 11 and U6 pin 10 (+ lead to pin 11).

3. Apply unit power and adjust R24 until the DVM indicates -0.25 ±0.01V dc.

4. Turn unit power off, remove the DVM connection at U6 and re-install the Clock Recovery PWB (A4).

5.6 REGIONAL SERVICE CENTERS

Regional Service Centers capable of performing periodic maintenance and providing assistance associated with the Model 4657B Analyzer and other Scientific-Atlanta equipment are listed below. Service Assistance for areas not listed can be provided through the Scientific-Atlanta Field Service Center, 4357 Park Drive, Suite G, Atlanta, Georgia 30093; TEL: 404-925-5122; TWX: 810-766-4912; TELEX: 542898.

SCIENTIFIC-ATLANTA REGIONAL SERVICE CENTERS
NORTH AMERICAN

California:
P.O. Box 2668
10039 S. Pioneer Blvd.
Santa Fe Springs, CA 90607
Tel: 213-949-9302

1701 Junction Court, Suite 100
San Jose, CA 95112
Tel: 408-993-8300

Colorado:
373 Inverness Drive, South
Suite 208
Englewood, CO 80112
Tel: 303-790-0585

Florida:
P.O. Box 2143
841 West Emmett Street
Kissimmee, FL 32741
Tel: 305-846-0055

Georgia:
4357-G Park Drive
Atlanta, Georgia 30093
Tel: 404-925-6074

Illinois:
Yorktown Office Center
621 E. Butterfield Road
Suite 219
Lombard, IL 60148
Tel: 312-963-6375

Indiana:
8755 Guion Road, Suite G
Indianapolis, IN 46268
Tel: 317-875-0057

Maryland:
Washington Business Park
5100-J Philadelphia Way
Lanham, MD 20706
Tel: 301-577-4830

Massachusetts:
220 Ballardville Street
Wilmington, MA 01887
Tel: 617-658-4310

New Jersey:
2100 Route 208
Fairlawn, NJ 07410
Tel: 201-794-3100

Texas:
8031 Airport Blvd., Suite 100
Houston, TX 77061
Tel: 713-640-2310

901 International Parkway, Suite 141
Richardson, TX 75081
Tel: 214-238-1116

Washington:
641 Strander Blvd.
Seattle, WA 98188
Tel: 206-575-8331

6/86

CHAPTER 6
PARTS LISTS

6.1 GENERAL

The parts lists for a Model 4657B DS3 Error Rate Analyzer are included in this chapter. Special modifications, if any, are enclosed in the envelope in the rear of this manual.

6.2 EXPLANATION OF COLUMN HEADINGS

REF. DESIG. PREFIX. This identifies the assigned reference designation applicable to a system or equipment sub-unit having a separate prefix and arrangement of individual components.

REF. DESIG. This identifies the components of the sub-unit in alphanumerical order.

PART NO. A five or six digit number assigned by Scientific-Atlanta to the specific part for identification and correct replacement ordering information.

DESCRIPTION. A brief electrical and/or mechanical description of the component.

FSCM CODE. The proper Federal Supply Code for Manufacturers is entered in this column. The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and are in effect as of the publication date of this manual.

VENDOR PART NUMBER. The number assigned to a part by an outside supplying manufacturer is listed in this column.

6.3 ORDERING PARTS

When ordering parts from Scientific-Atlanta, always include the Scientific-Atlanta part number, the part description, the unit name, the unit serial number, the subassembly name, the part manufacturer (FSCM), and the manufacturer's part number.

6.4 PARTS SUBSTITUTION

Common components may differ from those identified in the parts list. This difference is due to the substitution of a more current part during assembly. When this occurs, the replacement may be either a part identical to the type removed or a part meeting the description given in the parts list.

INDEX

Desig.	Ref Part No.	Description	Page
(1) A1	319249	Processor PWB Assembly	6-4
A2	304275	ECL Logic PWB Assembly	6-9
A3	317067	Power Supply PWB Assembly	6-14
A4	304284	Clock Recovery PWB Assembly	6-18
A5	304262	Front Panel Assembly	6-22
A5A1	304265	Front Panel PWB Assembly	6-23
A6	304278	Optional RS-232C Interface PWB Assembly	6-25
A6	304281	Optional IEEE-488 Interface PWB Assembly	6-27
A7	304267	Rear Panel Assembly	6-28

(1)

REF DESIG	PART NUMBER	SERIAL NUMBER*	
		FROM	TO
A1	317194	1	255
A1	319249	256	326
A1	317870	327	

* SERIAL NUMBER IS APPROXIMATE.

PROCESSOR PWB ASSEMBLY - 317870 (1)

REF DESIG PREFIX: 4657B-A1

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	304272	PWB SUB-ASSY PRCSR ANALYZER 4657B		
(1) 2	317868	EPROM AND LABEL ASSY MDL 4657B		

PWB SUBASSEMBLY - 304272

BT1	0316545	BATTERY,NICAD,PC MOUNT 3.6V	PER DESCP	
C1	0070470	CAPACITR 10 PF 500V SILVER MICA 5%	CD15CD100J03	14655
C2	0077512	CAPACITR 24 PF 500V SILVER MICA 5%	CD15ED240J03	14655
C3	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C4	0084221	CAPACITR .022 MF 100V CER MONO X7R 10%	8131-100-X7R-223K	72982
C5	0070525	CAPACITR 150 PF 1KV CER DISC S3N 10%	DD-151	71590
C6	0070470	CAPACITR 10 PF 500V SILVER MICA 5%	CD15CD100J03	14655
C7	0073491	CAPACITR 12 PF 500V SILVER MICA 5%	CD15CD120J03	14655
C8	0083649	CAPACITR 7-25 PF MIN CER DISC PC MT	538-011-B-7-25	72982
C9	0081808	CAPACITR 2.2 MF 50V CER MONO 20%	8141-050-651-225M	72982
C10	0080149	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	196D475X002JE3	
C11	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	DD-101	71590
C12	0087126	CAPACITR 1 MF 100V MET POLYESTER 10%	B32571-1/10/100	
C13	0087126	CAPACITR 1 MF 100V MET POLYESTER 10%	B32571-1/10/100	
C14	0087126	CAPACITR 1 MF 100V MET POLYESTER 10%	B32571-1/10/100	
C15	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C16	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C17	0035654	CAPACITR 10 MF 25V SOLID TANT POL 10%	T362B106K025AS	05397
C18	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C19	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C20	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C21	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C22	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C23	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C24	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C25	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C26	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C27	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C28	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C29	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C30	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C31	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C32	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C33	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C34	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C35	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C36	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C37	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C38	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C39	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C40	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C41	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C42	0081210	CAPACITR .01 MF 50V CER MONO 10%	8121-103K	72982
C43	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C44	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C45	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C46	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C47	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C48	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C49	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C50	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C51	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C52	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C53	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C54	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C55	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C56	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C57	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C58	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982

(1) SEE PAGE 6-8.

PWB SUBASSEMBLY - 304272 (cont.)

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
C59	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C60	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C61	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C62	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C63	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C64	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C65	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C66	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C67	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C68	0081210	CAPACITR .01 MF 50V CER MONO 10%	8121-103K	72982
C69	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C70	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C71	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C72	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C73	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C74	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C75	0086013	CAPACITR 22 MF 25V SOLID TANT POL 10%	T362C226K025AS	
C76	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
CR1	0083983	DIODE 1N5226B SI ZEN 3.3V 5% .5W	1N5226B	13715
CR2	0071122	DIODE 1N914 SIL 75V 75MA	1N914	80368
CR3	0071122	DIODE 1N914 SIL 75V 75MA	1N914	80368
CR4	0071142	DIODE 1N4154 SIL 25V 150MA	1N4154	80368
CR5	0071142	DIODE 1N4154 SIL 25V 150MA	1N4154	80368
CR6	0071142	DIODE 1N4154 SIL 25V 150MA	1N4154	80368
CR7	0071142	DIODE 1N4154 SIL 25V 150MA	1N4154	80368
J1	0170204	CONN RECT 50-COND FEMALE RT ANGL MT	552725-1	
J2	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
J3	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
J4	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
J5	0173953	CONN RECT 9-COND MALE RT ANGLE PC MT	HER HZM9RA29CP	
J6	0173955	CONN 40 PIN FWM DOUBLE ROW BOTTOM MT	86418 2	
J7	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
L1	0078046	INDUCTOR 3.3 UH SUBMIN UNSHLD 10%	IR-2	91637
L2	0079926	INDUCTOR 10 UH SUBMIN UNSHLD 10%	IR-2	91637
L3	0079926	INDUCTOR 10 UH SUBMIN UNSHLD 10%	IR-2	91637
LS1	0174610	ALARM TONE 3.8KHZ STEADY 80DB 3-20VDC	PKB8-4A0	
P1	0173957	CONN ASSY 50 PIN FEM DOUBLE RPC MT	2 8	
P2	0173957	CONN ASSY 50 PIN FEM DOUBLE ROW PC MT	2 86063 1	
P3	0317051	JUMPER .10 SPACING	480-1020611	
P4	0317051	JUMPER .10 SPACING	480-1020611	
P5	0317051	JUMPER .10 SPACING	480-1020611	
P6	0317051	JUMPER .10 SPACING	480-1020611	
Q1	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
Q2	0077148	TRANSSTR 2N3251 PNP SIL	2N3251	04713
Q3	0077148	TRANSSTR 2N3251 PNP SIL	2N3251	04713
Q4	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
Q5	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
Q6	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
Q7	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
Q8	0081544	TRANSSTR 2N4856 SIL FET N-CHNL JUNC	2N4856	01295
Q9	0081544	TRANSSTR 2N4856 SIL FET N-CHNL JUNC	2N4856	01295
Q10	0083712	TRANSSTR 2N5019 FET P-CHNL JUNC	2N5019	32293
Q11	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
R1	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R2	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R3	0072165	RESISTOR 470K OHM 1/4W 10% COMP	RCR07G474KS	01121
R4	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R5	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R6	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R7	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R8	0071897	RESISTOR 150 OHM 1/4W 10% COMP	RCR07G151KS	01121
R9	0072153	RESISTOR 330K OHM 1/4W 10% COMP	RCR07G334KS	01121
R10	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R11	0072002	RESISTOR 4.7K OHM 1/4W 10% CO	RCR07G472KS	01121

PWB SUBASSEMBLY - 304272 (cont.)

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
R12	0072077	RESISTOR 47K OHM 1/4W 10% COMP	RCR07G473KS	01121
R13	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R14	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R15	0081341	RESISTOR 22 MEG 1/4W 10% COMP	RCR07G226KS	01121
R16	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R17	0072189	RESISTOR 1.0 MEG 1/4W 10% COMP	RCR07G105KS	01121
R18	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R19	0072054	RESISTOR 22K OHM 1/4W 10% COMP	RCR07G223KS	01121
R20	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R21	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R22	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R23	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R24	0072014	RESISTOR 6.8K OHM 1/4W 10% COMP	RCR07G682KS	01121
R25	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R26	0072147	RESISTOR 270K OHM 1/4W 10% COMP	RCR07G274KS	01121
R27	0072147	RESISTOR 270K OHM 1/4W 10% COMP	RCR07G274KS	01121
R28	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R29	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R30	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R31	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R32	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R33	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R34	0171582	RESISTOR 49.9K OHM RN55C	RN55C4992B	
R35	0171582	RESISTOR 49.9K OHM RN55C	RN55C4992B	
R36	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R37	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R38	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R39	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R40	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R41	0171582	RESISTOR 49.9K OHM RN55C	RN55C4992B	
R42	0171582	RESISTOR 49.9K OHM RN55C	RN55C4992B	
R43	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R44	0078929	RESISTOR 1.00K OHM RN55C 1% MTL FLM	RN55C1001F	
R45	0083902	RESISTOR 3.01K OHM RN55C 1% MTL FLM	RN55C3011F	
R46	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R47	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R48	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R49	0083929	RESISTOR 30.1K OHM RN55C 1% MTL FLM	RN55C3012F	
R50	0071907	RESISTOR 220 OHM 1/4W 10% COMP	RCR07G221KS	01121
R51	0078929	RESISTOR 1.00K OHM RN55C 1% MTL FLM	RN55C1001F	
R52	0089522	POT 100K OHM 1/2W CER 3/8 SQ VER ADJ 25T	3299W-1-104	
R53	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM	RN55C1501F	
R54	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R55	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R56	0074714	RESISTOR 3.3K OHM 1/4W 5% COMP	RCR07G332JS	01121
R57	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R58	0071913	RESISTOR 270 OHM 1/4W 10% COMP	RCR07G271KS	01121
R59	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R60	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R61	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R62	0078600	NOT ASSIGNED	FOR ENG ONLY	
R63	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R64	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R65	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R66	0072113	RESISTOR 100K OHM 1/4W 10% COMP	RCR07G104KS	01121
R67	0072113	RESISTOR 100K OHM 1/4W 10% COMP	RCR07G104KS	01121
R68	0072113	RESISTOR 100K OHM 1/4W 10% COMP	RCR07G104KS	01121
R69	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R70	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R71	0078933	RESISTOR 10.0K OHM RN55C 1% MTL FLM	RN55C1002F	
R72	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	66XR5K	73138
R73	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R74	0071907	RESISTOR 220 OHM 1/4W 10% COMP	RCR07G221KS	01121
R75	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
RT1	0083617	THERMSTR 100 OHM DISC 25 DEG C 10%	FD21J1	15801
TP1	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	87220-3	
TP2	0087367	CONN HEADER SGL ROW STRAIGHT 4-PIN PC	87220-4	
U1	0086519	IC MICROPROCESSOR 8-BIT NMOS IMPROVED	D8080	
U2	0085188	IC CONTROLLER AND BUS DRIVER FOR 8080A	D8228	

PWB SUBASSEMBLY - 304272 (cont.)

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
U3	0085187	IC CLOCK GENERATOR FOR 8080A CPU	D8224	
U4	0085950	IC TTL LATCH 8-BIT TRANSPARENT 3-STATE	SN74LS373N	
U5	0086692	IC TTL GATE INVERTER HEX	SN74LS05J	
U6	0084000	VARIES WITH MODEL,SEE HIGHER ASSY FOR PN	PER S A DWG	
U7	0084000	VARIES WITH MODEL,SEE HIGHER ASSY FOR PN	PER S A DWG	
U8	0084000	VARIES WITH MODEL,SEE HIGHER ASSY FOR PN	PER S A DWG	
U9	0084000	VARIES WITH MODEL,SEE HIGHER ASSY FOR PN	PER S A DWG	
U10	0078600	NOT ASSIGNED	FOR ENG ONLY	
U11	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
U12	0078600	NOT ASSIGNED	FOR ENG ONLY	
U13	0171581	IC CMOS RAM 2048X8 200 NS STATIC	HM6116L-4	
U14	0171581	IC CMOS RAM 2048X8 200 NS STATIC	HM6116L-4	
U15	0084282	IC TTL GATE AND 2-IN QUAD	SN74LS08N	01295
U16	0086898	IC BUS TRANSCVR 8-BIT	SN74LS245N	
U17	0086898	IC BUS TRANSCVR 8-BIT	SN74LS245N	
U18	0087879	IC CMOS MULTI MONO RETRIG DUAL PREC	MC14538BCL	
U19	0083017	IC CMOS GATE NOR 2-IN QUAD	MC14001BCL	04713
U20	0083016	IC CMOS GATE NAND 2-IN QUAD	MC14011BCL	04713
U21	0089252	RESISTOR NETWORK 9 4.7K OHM 2% 10 SIP	4310R-101-472	
U22	0171539	RESISTOR NETWORK 5 3.3K OHM 2% 6 SIP	4306R-101-332	
U23	0087073	IC TTL LATCH NAND R/S QUAD	SN74LS279N	
U24	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
U25	0086646	IC TTL DECODER 2-BIT TO 1 OF 4 DUAL	SN74LS139N	
U26	0083806	IC TIMER 8L-DIP	NE555N	18324
U27	0170303	IC CLOCK CALENDAR FOR MICROS CMOS	MM58167N	
U28	0170205	IC CMOS COUNTER 14 STAGE BIN	CD4060AF	
U29	0085949	IC TTL BUFFER OCTAL 3-STATE	SN74LS244N	
U30	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	SN74LS74AN	01295
U31	0084960	IC TTL COUNTER BIN 35-MHZ	SN74LS161AN	01295
U32	0084281	IC TTL GATE INVERTER HEX	SN74LS04N	01295
U33	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	SN74LS74AN	01295
U34	0087804	IC TTL COUNTER BIN 35-MHZ DUAL	SN74LS393J	
U35	0087889	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE	SN74LS374N	
U36	0086641	IC PERIPHERAL INTERFACE PROGRAMMABLE	D8255A	
U37	0087092	RESISTOR NETWORK 9 22K OHM 2% 10 SIP	4310R-101-223	
U38	0087092	RESISTOR NETWORK 9 22K OHM 2% 10 SIP	4310R-101-223	
U39	0088053	IC INTERFACE CPU TO KEYBOARD AND DISPLAY	P8279-5	
U40	0086205	IC TTL BUFFER INVERT OCTAL 3-STATE	SN74LS240N	
U41	0086899	RESISTOR NETWORK 9 3.3K OHM 2% 10 SIP	785-1-R3.3K	
U42	0087800	RESISTOR NETWORK 8 220 OHM 2% 16 DIP	898-3-R220	
U43	0084281	IC TTL GATE INVERTER HEX	SN74LS04N	01295
U44	0083621	IC CMOS DECODER BCD TO DEC OR BIN/OCTL	MC14028BCL	04713
U45	0078600	NOT ASSIGNED	FOR ENG ONLY	
U46	0083621	IC CMOS DECODER BCD TO DEC OR BIN/OCTL	MC14028BCL	04713
U47	0078600	NOT ASSIGNED	FOR ENG ONLY	
U48	0171539	RESISTOR NETWORK 5 3.3K OHM 2% 6 SIP	4306R-101-332	
U49	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
U50	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL	SN74LS377N	
U51	0087800	RESISTOR NETWORK 8 220 OHM 2% 16 DIP	898-3-R220	
U52	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL	SN74LS377N	
U53	0087800	RESISTOR NETWORK 8 220 OHM 2% 16 DIP	898-3-R220	
U54	0086646	IC TTL DECODER 2-BIT TO 1 OF 4 DUAL	SN74LS139N	
U55	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
U56	0084285	IC TTL GATE OR 2-IN QUAD	SN74LS32N	01295
U57	0172414	IC TTL GATE NAND 2-IN QUAD	F74F00PC	
U58	0084281	IC TTL GATE INVERTER HEX	SN74LS04N	01295
U59	0088405	IC ECL TRANSLATOR ECL/TTL QUAD	F10125DC	
U60	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U61	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U62	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U63	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U64	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U65	0172312	IC TTL FLIP FLOP TYPED OCTAL 3ST 74F374	74F374PC	
U66	0172312	IC TTL FLIP FLOP TYPED OCTAL 3ST 74F374	74F374PC	
U67	0172312	IC TTL FLIP FLOP TYPED OCTAL 3ST 74F374	74F374PC	
U68	0086898	IC BUS TRANSCVR 8-BIT	SN74LS245N	
U69	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL	SN74LS377N	
U70	0087694	IC TTL BUFFER NAND 4-IN DUAL	SN74S140J	
U71	0087694	IC TTL BUFFER NAND 4-IN DUAL	SN74S140J	
U72	0086205	IC TTL BUFFER INVERT OCTAL 3-STATE	SN74LS240N	
U73	0083240	IC COMPARATOR-VOLTAGE 14L-DIP QUAD	LM339N	12040
U74	0170249	IC OP AMP 8L-DIP 70C COMP LO OFFSET	OP-07CP	

PWB SUBASSEMBLY - 304272 (cont.)

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
U75	0171576	IC A/D CONVERTER 4 1/2 DIGIT DUAL SLOPE	TL500C	
U76	0171580	IC DIGITAL PROCESSOR W/H BCD DRIVERS	TL503CN	
U77	0171579	IC VOLTAGE REFERENCE 5.0V	MC1404AU5	
U78	0089527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL	SN74LS390N	
U79	0084280	IC TTL GATE NOR 2-IN QUAD	SN74LS02N	01295
U80	0087086	RESISTOR NETWORK 7 4.7K OHM 2% 8 SIP	4308R-101-472	
U81	0084509	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO1 3STE	SN74LS251N	01295
U82	0087889	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE	SN74LS374N	
U83	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U84	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U85	0172312	IC TTL FLIP FLOP TYPED OCTAL 3ST 74F374	74F374PC	
U86	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
U87	0172312	IC TTL FLIP FLOP TYPED OCTAL 3ST 74F374	74F374PC	
U88	0089667	IC TTL GATE NAND 2-IN QUAD OPEN COL	SN74S03J	
U89	0089252	RESISTOR NETWORK 9 4.7K OHM 2% 10 SIP	4310R-101-472	
U90	0087981	IC TTL BUFFER QUAD 3-STATE	SN74LS125N	
U91	0086898	IC BUS TRANSCVR 8-BIT	SN74LS245N	
U92	0089838	RESISTOR NETWORK 9 100K OHM 2% 10 SIP	4310R 101 104	
U93	0089838	RESISTOR NETWORK 9 100K OHM 2% 10 SIP	4310R 101 104	
U94	0089252	RESISTOR NETWORK 9 4.7K OHM 2% 10 SIP	4310R-101-472	
U95	0173604	IC TTL COUNTER BIN 100-MHZ	74F161PC	
XU1	0086653	SOCKET 40 PIN DIP PC MT	ICT-406-S-T	
XU2	0086652	SOCKET 28 PIN DIP PC MT	ICT-286-S-TG30	
XU3	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU4	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU6	0086652	SOCKET 28 PIN DIP PC MT	ICT-286-S-TG30	
XU7	0086652	SOCKET 28 PIN DIP PC MT	ICT-286-S-TG30	
XU8	0086652	SOCKET 28 PIN DIP PC MT	ICT-286-S-TG30	
XU9	0086652	SOCKET 28 PIN DIP PC MT	ICT-286-S-TG30	
XU11	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU13	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU14	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU16	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU17	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU24	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU25	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU27	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU29	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU35	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU36	0086653	SOCKET 40 PIN DIP PC MT	ICT-406-S-T	
XU39	0086653	SOCKET 40 PIN DIP PC MT	ICT-406-S-T	
XU50	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU52	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU54	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU55	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU65	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU66	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU67	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU68	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU69	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU72	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU82	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU85	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU87	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU90	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU91	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
Y1	0087940	CRYSTAL 18.432 MHZ .0025% SERIES MODE	SCM 18 HOLDER	
Y2	0170302	CRYSTAL 32.768 KHZ .003% PARALLEL RES	CX-1V-32.768KHZ CA	

(1)

SERIAL NUMBER* FROM	SERIAL NUMBER* TO	PWB ASSEMBLY NUMBER	ITEM 2 PART NUMBER
1	225	317194	317384
226	326	319249	320126
327		317870	317868

* SERIAL NUMBER IS APPROXIMATE.

ECL LOGIC PWB ASSEMBLY - 304275

REF DESIG PREFIX: 4657B-A2

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0304361	PWB ECL LOGIC ERR RT ANALYZER MDL 4657B		
C1	0081101	CAPACITR 1 MF 50V CER MONO 20%	8131-050-651-105M	72982
C2	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C3	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C4	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C6	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C11	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C13	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C14	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C15	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C16	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C17	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C18	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C19	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C20	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C21	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C22	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C23	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C24	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C25	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C26	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C27	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C28	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C29	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C30	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C31	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C32	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C33	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C34	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C35	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C36	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C37	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C38	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C39	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
(1) C40	0070504	CAPACITR 50 PF 1 KV CER DISC S3N 10%	DD-500	71590
J1	0085182	CONN 20-PIN FEM DOUBLE ROW BOTTOM MT	86418-1	00779
J2	0089546	CONN HEADER DBL ROW STRAIGHT 8-PIN PC	87227-4	
J3	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	87220-3	
P1	0173957	CONN ASSY 50 PIN FEM DOUBLE ROW PC MT		
P2	0086884	JUMPER .10 SPACING	65474-004	
P3	0086884	JUMPER .10 SPACING	65474-004	
P4	0086884	JUMPER .10 SPACING	65474-004	
P5	0086884	JUMPER .10 SPACING	65474-004	
P6	0086884	JUMPER .10 SPACING	65474-004	
P7	0086884	JUMPER .10 SPACING	65474-004	
R1	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R2	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R3	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R4	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R5	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R6	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R7	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R8	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R9	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R10	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R11	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R12	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R13	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R14	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121

(1) APPLIES TO SERIAL NUMBER 27 AND ABOVE (APPROXIMATELY).

ECL LOGIC PWB ASSEMBLY - 304275

REF DESIG PREFIX: 4657B-A2

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
R15	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R16	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R17	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R18	0083867	RESISTOR 249 OHM RN55C 1% MTL FLM	RN55C2490F	
R19	0083855	RESISTOR 105 OHM RN55C 1% MTL FLM	RN55C1050F	
R20	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM	RN55C4990F	
R21	0083867	RESISTOR 249 OHM RN55C 1% MTL FLM	RN55C2490F	
R22	0083091	RESISTOR 140 OHM RN55C 1% MTL FLM	RN55C1400F	
R23	0071907	RESISTOR 220 OHM 1/4W 10% COMP	RCR07G221KS	01121
R24	0087835	POT 200 OHM 1/2W CER 3/8 SQ VERT ADJ 25T	3299W-1-201	
R25	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R26	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R27	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R28	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R29	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R30	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R31	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R32	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R33	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R34	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R35	0072113	RESISTOR 100K OHM 1/4W 10% COMP	RCR07G104KS	01121
R36	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R37	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R38	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R39	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R40	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R41	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R42	0072077	RESISTOR 47K OHM 1/4W 10% COMP	RCR07G473KS	01121
R43	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R44	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R45	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R46	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R47	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R48	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R49	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R50	0072054	RESISTOR 22K OHM 1/4W 10% COMP	RCR07G223KS	01121
R51	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R52	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R53	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R54	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R55	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R56	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R57	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R58	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R59	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R60	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R61	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R62	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R63	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R64	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R65	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R66	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R67	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R68	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R69	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R70	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R71	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R72	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R73	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R74	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R75	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R76	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R77	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R78	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R79	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R80	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R81	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R82	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R83	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R84	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R85	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121

ECL LOGIC PWB ASSEMBLY - 304275

REF DESIG PREFIX: 4657B-A2

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
R86	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R87	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R88	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R89	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R90	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R91	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R92	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R93	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R94	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R95	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R96	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R97	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R98	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R99	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R100	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R101	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R102	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R103	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R104	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R105	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R106	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R107	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R108	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R109	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R110	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R111	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R112	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R113	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R114	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R115	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R116	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R117	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R118	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R119	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R120	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R121	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R122	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R123	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R124	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R125	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R126	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R127	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R128	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R129	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R130	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R131	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R132	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R133	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R134	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R135	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R136	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R137	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R138	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R139	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R140	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R141	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R142	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R143	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R144	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R145	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R146	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R147	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R148	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R149	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R150	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R151	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R152	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R153	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R154	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R155	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R156	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121

ECL LOGIC PWB ASSEMBLY - 304275

REF DESIG PREFIX: 4657B-A2

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
R157	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R158	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R159	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R160	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R161	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R162	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R163	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R164	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R165	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R166	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R167	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R168	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R169	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R170	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R171	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R172	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R173	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R174	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R175	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
U1	0089654	IC ECL GATE NOR/OR 2/3/2-IN TRIPLE	F10105DC	
U2	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL	F10131DC	
U3	0089654	IC ECL GATE NOR/OR 2/3/2-IN TRIPLE	F10105DC	
U4	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV	F10135DC	
U5	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL	F10131DC	
U6	0086633	IC ECL LINE RECEIVER QUAD	MC10115L	
U7	0086633	IC ECL LINE RECEIVER QUAD	MC10115L	
U8	0170206	IC ECL TRANSLATOR TTL TO ECL QUAD	F10124DC	
U9	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL	F10131DC	
U10	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U11	0089656	IC ECL GATE EX OR/NOR 2-IN TRIPLE	F10107DC	
U12	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ	F10016DC	
U13	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL	F10131DC	
U14	0088405	IC ECL TRANSLATOR ECL/TTL QUAD	F10125DC	
U15	0087867	IC TTL MULTI MONO RETRIG DUAL	SN74LS123J	
U16	0089662	IC ECL REGISTER 4-BIT SHIFT	F10141DC	
U17	0089662	IC ECL REGISTER 4-BIT SHIFT	F10141DC	
U18	0089662	IC ECL REGISTER 4-BIT SHIFT	F10141DC	
U19	0089662	IC ECL REGISTER 4-BIT SHIFT	F10141DC	
U20	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ	F10016DC	
U21	0089660	IC ECL COUNTER 4-BIT BINARY 200-MHZ	F10136DC	
U22	0089660	IC ECL COUNTER 4-BIT BINARY 200-MHZ	F10136DC	
U23	0089660	IC ECL COUNTER 4-BIT BINARY 200-MHZ	F10136DC	
U24	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND	F10104DC	
U25	0170207	IC TTL GATE OR 2-IN QUAD	74F32PC	
U26	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U27	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV	F10135DC	
U28	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U29	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND	F10104DC	
U30	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV	F10135DC	
U31	0089656	IC ECL GATE EX OR/NOR 2-IN TRIPLE	F10107DC	
U32	0089652	IC ECL GATE OR 2-IN QUAD 3 OR-1 OR/NOR	F10103DC	
U33	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND	F10104DC	
U34	0089655	IC ECL GATE NOR 4/3/3-IN TRIPLE	F10106DC	
U35	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL	F10131DC	
U36	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ	F10016DC	
U37	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ	F10016DC	
U38	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ	F10016DC	
U39	0086633	IC ECL LINE RECEIVER QUAD	MC10115L	
U40	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ	F10016DC	
U41	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ	F10016DC	
U42	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U43	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U44	0089662	IC ECL REGISTER 4-BIT SHIFT	F10141DC	
U45	0089662	IC ECL REGISTER 4-BIT SHIFT	F10141DC	
U46	0089661	IC ECL COUNTER DECADE 200-MHZ	F10137DC	
U47	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U48	0089656	IC ECL GATE EX OR/NOR 2-IN TRIPLE	F10107DC	
U49	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV	F10135DC	
U50	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL	F10131DC	

ECL LOGIC PWB ASSEMBLY - 304275

REF DESIG PREFIX: 4657B-A2

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
U51	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND	F10104DC	
U52	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U53	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND	F10104DC	
U54	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV	F10135DC	
U55	0088405	IC ECL TRANSLATOR ECL/TTL QUAD	F10125DC	
U56	0087694	IC TTL BUFFER NAND 4-IN DUAL	SN74S140J	
U57	0087694	IC TTL BUFFER NAND 4-IN DUAL	SN74S140J	
U58	0088405	IC ECL TRANSLATOR ECL/TTL QUAD	F10125DC	
U59	0084831	IC TTL COUNTER DECADE 90-MHZ	93S10DC	13715
U60	0081797	IC TTL COUNTER DECADE 50-MHZ 2X5	SN74196N	01295
U61	0089664	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL	SN74LS390J	
U62	0089664	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL	SN74LS390J	
U63	0172313	IC TTL FLIP-FLOP TYPE D DUAL	F74F74PC	
U64	0087867	IC TTL MULTI MONO RETRIG DUAL	SN74LS123J	
U65	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV	F10135DC	
U66	0089662	IC ECL REGISTER 4-BIT SHIFT	F10141DC	

POWER SUPPLY PWB ASSEMBLY - 317067
REF DESIGN PREFIX: 4657B-A3

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
	0304310	PWR SPLY_SW MODE SCHEM DIAG ERTS	PER SA DWG	
C1	0174621	CAPACITR .01 MF 500V CER DISC Z5U-20+80%	5HKSS10	
C2	0174621	CAPACITR .01 MF 500V CER DISC Z5U-20+80%	5HKSS10	
C3	0174621	CAPACITR .01 MF 500V CER DISC Z5U-20+80%	5HKSS10	
C4	0174621	CAPACITR .01 MF 500V CER DISC Z5U-20+80%	5HKSS10	
C5	0174621	CAPACITR .01 MF 500V CER DISC Z5U-20+80%	5HKSS10	
C6	0174621	CAPACITR .01 MF 500V CER DISC Z5U-20+80%	5HKSS10	
C7	0173962	CAPACITR 220 MF 200V RADIAL LEADS SEAL	80D221P200JC5	
C8	0173962	CAPACITR 220 MF 200V RADIAL LEADS SEAL	80D221P200JC5	
C9	0170263	CAPACITR 100 MF 20V	672D107H020CG5C	
C10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C11	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C12	0080140	CAPACITR .0047 MF 50V MOLDED POLYESTER	65F10AA472	24446
C13	0175311	CAP .01MF 160V MLD PLYSTR 10%	103KX2RB3AL4	
C14	0175419	CAPACITR 4.7 MF 63V RDL LEADS	503D475M063KA	
C15	0081101	CAPACITR 1 MF 50V CER MONO 20%	8131-050-651-105M	72982
C16	0175310	CAP .0022MF 100V MET PLYSTR 10	IR77222K	
C17	0077920	CAPACITR 1 MF 50V CER MONO 20%	5CZ5U105X0050C5	
C18	0173964	CAPACITR .05 MF 500V CER DISC Z5U 20%	5GA-S50	
C19	0173963	CAPACITR 1 MF 250V MET POLYPROPYLENE10%	105K25MP1200P3	
C20	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	DD102	71590
C21	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C22	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C23	0173965	CAPACITR 1500 MF 6.3V RADIAL LEADS SEAL	672D158H6R3ET5C	
C24	0081808	CAPACITR 2.2 MF 50V CER MONO 20%	8141-050-651-225M	72982
C25	0173965	CAPACITR 1500 MF 6.3V RADIAL LEADS SEAL	672D158H6R3ET5C	
C26	0081808	CAPACITR 2.2 MF 50V CER MONO 20%	8141-050-651-225M	72982
C27	0081808	CAPACITR 2.2 MF 50V CER MONO 20%	8141-050-651-225M	72982
C28	0173966	CAPACITR 330 MF 40V RADIAL LEADS SEAL	672D337H040ET5C	
C29	0081808	CAPACITR 2.2 MF 50V CER MONO 20%	8141-050-651-225M	72982
C30	0173966	CAPACITR 330 MF 40V RADIAL LEADS SEAL	672D337H040ET5C	
C31	0081808	CAPACITR 2.2 MF 50V CER MONO 20%	8141-050-651-225M	72982
C32	0175312	CAP .012MF 160V MLD PLYSTR 10%	123KX2RB3AL4	
C33	0089643	CAPACITR 1000 MF 15V	672D108H015ET5C	
C34	0170264	CAPACITR 1 MF 100V CER MONO 651 20%	8141-100-651-105M	
C35	0170264	CAPACITR 1 MF 100V CER MONO 651 20%	8141-100-651-105M	
C36	0170264	CAPACITR 1 MF 100V CER MONO 651 20%	8141-100-651-105M	
C37	0081101	CAPACITR 1 MF 50V CER MONO 20%	8131-050-651-105M	72982
C38	0081101	CAPACITR 1 MF 50V CER MONO 20%	8131-050-651-105M	72982
C39	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C40	0078600	NOT ASSIGNED	FOR ENG ONLY	
C41	0078600	NOT ASSIGNED	FOR ENG ONLY	
C42	0173968	CAPACITR150 MF 60V RADIAL LEADS SEAL	672D157H060ET5C	
C43	0173968	CAPACITR150 MF 60V RADIAL LEADS SEAL	672D157H060ET5C	
C44	0087221	CAPACITR 10 MF 25V PC MT	106RAR025A	
C45	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C46	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C47	0175311	CAP .01MF 160V MLD PLYSTR 10%	103KX2RB3AL4	
C48	0175419	CAPACITR 4.7 MF 63V RDL LEADS	503D475M063KA	
C49	0078600	NOT ASSIGNED	FOR ENG ONLY	
C50	0086013	CAPACITR 22 MF 25V SOLID TANT POL 10%	T362C226K025AS	
C51	0077920	CAPACITR 1 MF 50V CER MONO 20%	5CZ5U105X0050C5	
C52	0170264	CAPACITR 1 MF 100V CER MONO 651 20%	8141-100-651-104Z	
C53	0075417	CAPACITR .01 MF 150V CER DISC Z5V-40+60%	DDM-103	71590
C54	0173968	CAPACITR150 MF 60V RADIAL LEADS SEAL	672D157H060ET5C	
C55	0082952	CAPACITR 220 PF 1KV CER DISC Z5F 10%	DD-221	71590
C56	0078600	NOT ASSIGNED	FOR ENG ONLY	
C57	0078600	NOT ASSIGNED	FOR ENG ONLY	
C58	0170264	CAPACITR 1 MF 100V CER MONO 651 20%	8141-100-651-105M	
C59	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982

POWER SUPPLY PWB ASSEMBLY - 317067 (cont.)

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
CR8	0173970	DIODE 1N4764A SI ZEN 100V 5% 1W	1N4764A	
CR9	0173970	DIODE 1N4764A SI ZEN 100V 5% 1W	1N4764A	
CR10	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	1N4746A	04713
CR11	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	1N4746A	04713
CR12	0071122	DIODE 1N914 SIL 75V 75MA	1N914	80368
CR13	0071122	DIODE 1N914 SIL 75V 75MA	1N914	80368
CR14	0173973	DIODE MBR735 SIL 35V 7.5SCHOTKY	MBR735	
CR15	0173972	DIODE VHE1402 SIL 100V 10A TO 220V	VHE1402	
CR16	0173973	DIODE MBR735 SIL 35V 7.5SCHOTKY	MBR735	
CR17	0173972	DIODE VHE1402 SIL 100V 10A TO 220V	VHE1402	
CR18	0089538	DIODE 1N6267A ZEN TRAN SUPPRESSOR 6.8 V	1N6267A	
CR19	0089538	DIODE 1N6267A ZEN TRAN SUPPRESSOR 6.8 V	1N6267A	
CR20	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR21	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR22	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR23	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR24	0078274	DIODE 1N4002 SIL 100V 1A	1N4002	04713
CR25	0089539	DIODE 1N6275A ZEN TRAN SUPPRESSOR 15 V	1N6275A	
CR26	0078274	DIODE 1N4002 SIL 100V 1A	1N4002	04713
CR27	0089539	DIODE 1N6275A ZEN TRAN SUPPRESSOR 15 V	1N6275A	
CR28	0078274	DIODE 1N4002 SIL 100V 1A	1N4002	04713
CR29	0089539	DIODE 1N6275A ZEN TRAN SUPPRESSOR 15 V	1N6275A	
CR30	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	1N4746A	04713
CR31	0081865	DIODE 1N4999 SIL 200V 3A PC MOUNT	1N4999	04713
CR32	0071143	DIODE 1N4735A SI ZEN 6.2V 5% 1W	1N4735A	04713
CR33	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	1N4744A	04713
CR34	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	1N4744A	04713
CR35	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	1N4744A	04713
CR36	0079912	DIODE 1N4736A SI ZEN 6.8V 5% 1W	1N4736A	04713
CR37	0078600	NOT ASSIGNED	FOR ENG ONLY	
CR38	0078600	NOT ASSIGNED	FOR ENG ONLY	
CR39	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	1N4744A	04713
CR40	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	1N4746A	04713
CR41	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	1N4746A	04713
CR42	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR43	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR44	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR45	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR46	0173969	DIODE 1N4757A SI ZEN 51V 5% 1W	1N4757A	
CR47	0173970	DIODE 1N4764A SI ZEN 100V 5% 1W	1N4764A	
CR48	0173970	DIODE 1N4764A SI ZEN 100V 5% 1W	1N4764A	
CR49	0071121	DIODE 1N821 TC REF 6.2V .01% .4W	1N821	04713
CR50	0078600	NOT ASSIGNED	FOR ENG ONLY	
CR51	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR52	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR53	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR54	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR55	0076449	DIODE 1N4752A SI ZEN 33V 5% 1W	1N4752A	04713
CR56	0078274	DIODE 1N4002 SIL 100V 1A	1N4002	04713
CR57	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR58	0175314	DIODE IN6293A Z TRAN SUPPR 82V	1N6293A	
CR59	0175314	DIODE IN6293A Z TRAN SUPPR 82V	1N6293A	
CR60	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR61	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR62	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR63	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
CR64	0173971	DIODE 1N4937SIL 600V 1A FAST REC.	1N4937	
F1	0174613	FUSE 6 AMP 125 VOLT	8AG 362006	
F2	0174613	FUSE 6 AMP 125 VOLT	8AG 362006	
J1	0174617	CONN HEADER SGL ROW STRAIGHT 12-PIN PC	HLSS156-12	
J2	0037492	CONN RECEPT DBL ROW RT ANGLE 40-PIN PC	PER S A DWG	
J3	0173932	CONN RECT PIN HOUSING 3 CIRCUITS RT ANGL	1-350947-0	
J4	0174616	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	HLSS156-3	
J5	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
J6	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
K1	0174793	RLY 48VDC DPDT PC MT ENCL 6A 28VDC	W76URCPCX-36	

POWER SUPPLY PWB ASSEMBLY - 317067 - continued
REF DESIGN PREFIX: 4657B-A3

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
J1	0174617	CONN HEADER SGL ROW STRAIGHT 12-PIN PC	MLSS156-12	
J2	0037492	CONN RECEPT DBL ROW RT ANGLE 40-PIN PC	PER S A DWG	
J3	0173932	CONN RECT PIN HOUSING 3 CIRCUITS RT ANGL	1-350947-0	
J4	0174616	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	MLSS156-3	
J5	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
J6	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
K1	0174793	RLY 48VDC DPDT PC MT ENCL 6A 28VDC	W76URCPCX-36	
L1	0304334	INDUCTOR, AC LINE	PER DWG	
L2	0304397	INDUCTOR, 22 UH SMPS	PER DWG	
L3	0304397	INDUCTOR, 22 UH SMPS	PER DWG	
L4	0304398	INDUCTOR, 220 UH, SMPS	PER DWG	
L5	0304398	INDUCTOR, 220 UH, SMPS	PER DWG	
L6	0304333	INDUCTOR, DE LINE SW PWR SPLY	PER DWG	
L7	0304399	INDUCTOR, 10 MH SMPS	PER DWG	
Q1	0173974	TRANSSTR TIP 50 NPN SIL 400 BVCEO	TIP50	
Q2	0078215	TRANSSTR 2N5089 NPN SIL	2N5089	04713
Q3	0313353	TRANSSTR,FET N-CHNL MOS 450-500V,TO-220	PER SA DWG	
Q4	0313353	TRANSSTR,FET N-CHNL MOS 450-500V,TO-220	PER SA DWG	
Q5	0313320	TRANSSTR,FET N-CHNL MOS 80-100V,TO-220	PER DISCP	
Q6	0078600	NOT ASSIGNED	FOR ENG ONLY	
Q7	0078600	NOT ASSIGNED	FOR ENG ONLY	
Q8	0084113	TRANSSTR TIP 111 NPN SIL DARLINGTON PAIR	TIP 111	01295
Q9	0313352	TRANSSTR,FET N-CHNL MOS 180-200V,TO-220	PER SA DWG	
Q10	0313352	TRANSSTR,FET N-CHNL MOS 180-200V,TO-220	PER SA DWG	
Q11	0313352	TRANSSTR,FET N-CHNL MOS 180-200V,TO-220	PER SA DWG	
Q12	0313352	TRANSSTR,FET N-CHNL MOS 180-200V,TO-220	PER SA DWG	
Q13	0084113	TRANSSTR TIP 111 NPN SIL DARLINGTON PAIR	TIP 111	01295
Q14	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	
R1	0075698	RESISTOR 100K OHM 1/2W 10% COMP	RCR20G104KS	01121
R2	0075698	RESISTOR 100K OHM 1/2W 10% COMP	RCR20G104KS	01121
R3	0072114	RESISTOR 100K OHM 1W 10% COMP	RCR32G104KS	01121
R4	0173268	RESISTOR 5.6K OHM 5W WW 5%	PW-5-5.6K -5%	
R5	0075608	RESISTOR 120 OHM 2W 10% COMP	RCR42G121KS	01121
R6	0087418	RESISTOR 10 OHM 5W WW 5%	VAL5	
R7	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R8	0071889	RESISTOR 100 OHM 1/2W 10% COMP	RCR20G101KS	01121
R9	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R10	0083878	RESISTOR 562 OHM RN55C 1% MTL FLM	RN55C5620F	
R11	0072042	RESISTOR 15.0K OHM 3W 3%	RS2B	91637
R12	0082922	RESISTOR 10 MEG 1/4W 5% COMP	RCR07G106JS	01121
R13	0072054	RESISTOR 22K OHM 1/4W 10% COMP	RCR07G223KS	01121
R14	0072077	RESISTOR 47K OHM 1/4W 10% COMP	RCR07G473KS	01121
R15	0072077	RESISTOR 47K OHM 1/4W 10% COMP	RCR07G473KS	01121
R16	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R17	0173268	RESISTOR 5.6K OHM 5W WW 5%	PW-5-5.6K -5%	
R18	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R19	0078600	NOT ASSIGNED	FOR ENG ONLY	
R20	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM	RN55C1501F	
R21	0078600	NOT ASSIGNED	FOR ENG ONLY	
R22	0076282	RESISTOR 4.7 OHM 1/4W 10% COMP	RCR07G4R7KS	01121
R23	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R24	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R25	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R26	0078600	NOT ASSIGNED	FOR ENG ONLY	
R27	0078600	NOT ASSIGNED	FOR ENG ONLY	
R28	0076275	RESISTOR 22 OHM 1/4W 10% COMP	RCR07G220KS	01121
R29	0076275	RESISTOR 22 OHM 1/4W 10% COMP	RCR07G220KS	01121
R30	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R31	0075698	RESISTOR 100K OHM 1/2W 10% COMP	RCR20G104KS	01121
R32	0071891	RESISTOR 100 OHM 2W 10% COMP	RCR42G101KS	01121
R33	0076275	RESISTOR 22 OHM 1/4W 10% COMP	RCR07G220KS	01121
R34	0076275	RESISTOR 22 OHM 1/4W 10% COMP	RCR07G220KS	01121
R35	0078600	NOT ASSIGNED	FOR ENG ONLY	
R36	0078600	NOT ASSIGNED	FOR ENG ONLY	
R37	0078600	NOT ASSIGNED	FOR ENG ONLY	
R38	0072214	RESISTOR 4.7 MEG 1/4W 10% COMP	RCR07G475KS	01121

POWER SUPPLY PWB ASSEMBLY - 317067 - continued
REF DESIGN PREFIX: 4657B-A3

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
R39	0075542	RESISTOR 2.7 OHM 1/2W 5% COMP	RCR20G2R7JS	01121
R40	0078600	NOT ASSIGNED	FOR ENG ONLY	
R41	0078600	NOT ASSIGNED	FOR ENG ONLY	
R42	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R43	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R44	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R45	0071926	RESISTOR 470 OHM 1/4W 10% COMP	RCR07G471KS	01121
R46	0078600	NOT ASSIGNED	FOR ENG ONLY	
R47	0078600	NOT ASSIGNED	FOR ENG ONLY	
R48	0078600	NOT ASSIGNED	FOR ENG ONLY	
R49	0078600	NOT ASSIGNED	FOR ENG ONLY	
R50	0078600	NOT ASSIGNED	FOR ENG ONLY	
R51	0072028	RESISTOR 10K OHM 1/2W 10% COMP	RCR20G103KS	01121
R52	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R53	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	RCR07G822KS	01121
R54	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R55	0083903	RESISTOR 3.32K OHM RN55C 1% MTL FLM	RN55C3321F	
R56	0076282	RESISTOR 4.7 OHM 1/4W 10% COMP	RCR07G4R7KS	01121
R57	0076282	RESISTOR 4.7 OHM 1/4W 10% COMP	RCR07G4R7KS	01121
R58	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	RCR07G152KS	01121
R59	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R60	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R61	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R62	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R63	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R64	0071839	RESISTOR 10 OHM 2W 10% COMP	RCR42G100KS	01121
R65	0071839	RESISTOR 10 OHM 2W 10% COMP	RCR42G100KS	01121
R66	0174771	RESISTOR 0.025 OHM 2W 1%	LVR-2 0.025 OHM 1%	
R67	0071956	RESISTOR 1.0K OHM 2W 10% COMP	RCR42G102KS	01121
R68	0071956	RESISTOR 1.0K OHM 2W 10% COMP	RCR42G102KS	01121
R69	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R70	0072040	RESISTOR 15K OHM 1/2W 10% COMP	RCR20G153KS	01121
R71	0072086	RESISTOR 50K OHM 5W 1%	RS5	91637
R72	0084055	RESISTOR 681 OHM RN55C 1% MTL FLM	RN55C6810F	
R73	0087838	POT 2K OHM 1/2W CER 3/8 SQ VERT ADJ 25T	3299W-1-202	
R74	0083908	RESISTOR 4.64K OHM RN55C 1% MTL FLM	RN55C4641F	
R75	0072054	RESISTOR 22K OHM 1/4W 10% COMP	RCR07G223KS	01121
R76	0072046	RESISTOR 18K OHM 1/4W 10% COMP	RCR07G183KS	01121
R77	0071941	RESISTOR 820 OHM 1/4W 10% COMP	RCR07G821KS	01121
R78	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R79	0072165	RESISTOR 470K OHM 1/4W 10% COMP	RCR07G474KS	01121
R80	0071978	RESISTOR 2.2K OHM 1/2W 10% COMP	RCR20G222KS	01121
R81	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R82	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R83	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R84	0083878	RESISTOR 562 OHM RN55C 1% MTL FLM	RN55C5620F	
R85	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R86	0072054	RESISTOR 22K OHM 1/4W 10% COMP	RCR07G223KS	01121
R87	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R88	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R89	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R90	0075590	RESISTOR 56 OHM 2W 10% COMP	RCR42G560KS	01121
RT1	0317600	THERMSTR 120 OHM DISC 25 DEG C	-90	
RT2	0317600	THERMSTR 120 OHM DISC 25 DEG C	-90	
RT3	0175463	THERMSTR 500 OHM 80 DEG C PTC SWG	RL3006-50-80-25-PTO	
RT4	0175463	THERMSTR 500 OHM 80 DEG C PTC SWG	RL3006-50-80-25-PTO	
RV1	0081844	VARISTOR 150V RMS .5 WATTS	V150LA10A	24446
RV2	0081844	VARISTOR 150V RMS .5 WATTS	V150LA10A	24446
T1	0304285	XFMR, GATE DRIVE SW PWR SPL SER 4650	PER DWG	
T2	0174615	SENSOR CURRENT FOR SWITCHING PWR SUPPLY	51718	
T3	0304287	XFMR PWR/STP DN SW PWR3PLY4650	PER DWG	
T4	0304286	XFMR, PWR STEP UP SW SPLY SER 4650	PER DWG	

POWER SUPPLY PWB ASSEMBLY - 317067 - continued
REF DESIGN PREFIX: 4657B-A3

U1	0173978	IC VLTG RGLTR?PW MOD 125C	SG3526J	
U2	0173979	OPTO-ISOLATOR 2.5 KVDC SCR 400PRV 0.3ARM	H11C4	
U3	0174715	OPTO-ISOLA 3.55KVDC NPN PXSTR	4N35	
U4	0085294	IC VLTG RGLTR POS 12V 0.5A TYP TO220	MC7812CT	04713
U5	0085294	IC VLTG RGLTR POS 12V 0.5A TYP TO220	MC7812CT	04713
U6	0085295	IC VLTG RGLTR NEG 12V 0.5A TYP TO220	MC7912CT	04713
U7	0086204	OPTO-ISOLATOR NPN PHOTOTRANSISTOR DIP	4N28	
U8	0078600	NOT ASSIGNED	FOR ENG ONLY	
U9	0078600	NOT ASSIGNED	FOR ENG ONLY	
U10	0078600	NOT ASSIGNED	FOR ENG ONLY	
U11	0081840	IC OP AMP 8L-DIP 70C COMP DUAL 741C	MC1458P	79089
U12	0173978	IC VLTG RGLTR?PW MOD 125C	SG3526J	
U13	0174715	OPTO-ISOLA 3.55KVDC NPN PXSTR	4N35	

CLOCK RECOVERY PWB ASSEMBLY - 304284

REF DESIG PREFIX: 4657B-A4

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0304364	PWB CLOCK RECOVERY ERR RT ANALYZR 4657B		
C1	0081834	CAPACITR 77 PF 500V SILVER MICA 2%	D155C770G03	53021
C2	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C3	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C4	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C6	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C7	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C9	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C10	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C11	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C12	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C14	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C15	0070504	CAPACITR 50 PF 1KV CER DISC S3N 10%	DD-500	71590
C16	0070504	CAPACITR 50 PF 1KV CER DISC S3N 10%	DD-500	71590
C17	0081792	CAPACITR 30 PF 100V CER DISC U1G 5%	805-024-U1G0-300J	72982
C18	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C19	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C20	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C21	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C22	0070556	CAPACITR .003 MF 1KV CER DISC Z5U 20%	DD302	71590
C23	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C24	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C25	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C26	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C27	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C28	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C29	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C30	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C31	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C32	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C33	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C34	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C35	0070540	CAPACITR 470 PF 1KV CER DISC Z5F 10%	DD-471	71590
C36	0070540	CAPACITR 470 PF 1KV CER DISC Z5F 10%	DD-471	71590
C37	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C38	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C39	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C40	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C41	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C42	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C43	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C44	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C45	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C46	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C47	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C48	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C49	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C50	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C51	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C52	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C53	0035654	CAPACITR 10 MF 25V SOLID TANT POL 10%	T362B106K025AS	05397
C54	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C55	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C56	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C57	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	T362D107K020AS	05397
C58	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C59	0035654	CAPACITR 10 MF 25V SOLID TANT POL 10%	T362B106K025AS	05397
C60	0035761	CAPACITR 5.0 PF 500V CER DISC COH +-.25P	831-COHO-509C	72982
C61	0035761	CAPACITR 5.0 PF 500V CER DISC COH +-.25P	831-COHO-509C	72982
C62	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C63	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C64	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C65	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C66	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C67	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982

CLOCK RECOVERY PWB ASSEMBLY - 304284

REF DESIG PREFIX: 4657B-A4

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
C68	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C69	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C70	0073486	CAPACITR 1 MF 500V CER TUBULAR	CC20CK010C	00656
C71	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
C72	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104K	72982
C73	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	8121-050-X7R-103K	72982
CR1	0255147	DIODE PIN		
CR2	0255147	DIODE PIN		
CR3	0255147	DIODE PIN		
CR4	0071142	DIODE 1N4154 SIL 25V 150MA	1N4154	80368
CR5	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	5082-2800	28480
CR6	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	5082-2800	28480
CR7	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	5082-2800	28480
CR8	0071122	DIODE 1N914 SIL 75V 75MA	1N914	80368
CR9	0071122	DIODE 1N914 SIL 75V 75MA	1N914	80368
CR10	0174710	DIODE KV1801 VARACTOR SIL WIRE LEADS	KV1801	
CR11	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	5082-2800	28480
CR12	0071122	DIODE 1N914 SIL 75V 75MA	1N914	80368
E1	0081718	CORE BEAD FERRITE 7D .138X.037X.150L GRN	57-1413	78488
E2	0081718	CORE BEAD FERRITE 7D .138X.037X.150L GRN	57-1413	78488
J1	0084940	CONN COAX SMB MALE PC MT 75 OHM	51-151-0000	98291
J2	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	87220-3	
J3	0084940	CONN COAX SMB MALE PC MT 75 OHM	51-151-0000	98291
J4	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	87220-3	
J5	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	87220-3	
(1) J6	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC	87220-3	
K1	0173958	RELAY 12VDC DPDT CENTIGRID	TED172-12	
L1	0079330	INDUCTOR .22 UH SUBMIN UNSHLD 10%	IR-2	91637
L2	0079330	INDUCTOR .22 UH SUBMIN UNSHLD 10%	IR-2	91637
L3	0079166	INDUCTOR .15 UH SUBMIN UNSHLD 10%	IR-2	91637
L4	0079167	INDUCTOR .33 UH SUBMIN UNSHLD 10%	IR-2	91637
L5	0079167	INDUCTOR .33 UH SUBMIN UNSHLD 10%	IR-2	91637
L6	0080599	INDUCTOR 4.7 UH SUBMIN UNSHLD 10%	IR-2	91637
L7	0079167	INDUCTOR .33 UH SUBMIN UNSHLD 10%	IR-2	91637
L8	0079926	INDUCTOR 10 UH SUBMIN UNSHLD 10%	IR-2	91637
L9	0079926	INDUCTOR 10 UH SUBMIN UNSHLD 10%	IR-2	91637
L10	0077944	INDUCTOR .27 UH SUBMIN UNSHLD 10%	IR-2	91637
L11	0077944	INDUCTOR .27 UH SUBMIN UNSHLD 10%	IR-2	91637
L12	0077944	INDUCTOR .27 UH SUBMIN UNSHLD 10%	IR-2	91637
L13	0077944	INDUCTOR .27 UH SUBMIN UNSHLD 10%	IR-2	91637
P1	0084930	CONN HEADER DBL ROW STRAIGHT 20-PIN PC	1-87227-0	00779
P2	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P3	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P4	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
(1) P5	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
Q1	0077148	TRANSSTR 2N3251 PNP SIL	2N3251	04713
Q2	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q3	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q4	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q5	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q6	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q7	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	2N6427	04713
Q8	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q9	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q10	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q11	0075091	TRANSSTR 2N2857 NPN SIL	2N2857	04713
Q12	0085042	TRANSSTR MRF 517 NPN SIL	MRF 517	04713
R1	0083855	RESISTOR 105 OHM RN55C 1% MTL FLM	RN55C105OF	
R2	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM	RN55C75ROF	
R3	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM	RN55C75ROF	
R4	0078919	RESISTOR 44.2 OHM RN55D 1% MTL FLM	RN55C44R2F	

(1) APPLIES TO SERIAL NUMBER 153 AND ABOVE (APPROXIMATELY).

CLOCK RECOVERY PWB ASSEMBLY - 304284

REF DESIG PREFIX: 4657B-A4

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
R5	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM	RN55C75R0F	
R6	0071889	RESISTOR 100 OHM 1/2W 10% COMP	RCR20G101KS	01121
R7	0071960	RESISTOR 1.2K OHM 1/4W 10% COMP	RCR07G122KS	01121
R8	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R9	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R10	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R11	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R12	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R13	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R14	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R15	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R16	0078915	RESISTOR 221 OHM RN55C 1% MTL FLM	RN55C2210F	
R17	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R18	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R19	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R20	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R21	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R22	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R23	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R24	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R25	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R26	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R27	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R28	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R29	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R30	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R31	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R32	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R33	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R34	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R35	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R36	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R37	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R38	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R39	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R40	0072113	RESISTOR 100K OHM 1/4W 10% COMP	RCR07G104KS	01121
R41	0079864	RESISTOR 24.9K OHM RN55C 1% MTL FLM	RN55C2492F	
R42	0087840	POT 10K OHM 1/2W CER 3/8 SQ VERT ADJ 25T	3299W-1-103	
R43	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R44	0072138	RESISTOR 220K OHM 1/4W 10% COMP	RCR07G224KS	01121
R45	0072059	RESISTOR 27K OHM 1/4W 10% COMP	RCR07G273KS	01121
R46	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R47	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R48	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R49	0072189	RESISTOR 1.0 MEG 1/4W 10% COMP	RCR07G105KS	01121
R50	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R51	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R52	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R53	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R54	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R55	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R56	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R57	0083097	RESISTOR 332 OHM RN55C 1% MTL FLM	RN55C3320F	
R58	0083097	RESISTOR 332 OHM RN55C 1% MTL FLM	RN55C3320F	
R59	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R60	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R61	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R62	0072014	RESISTOR 6.8K OHM 1/4W 10% COMP	RCR07G682KS	01121
R63	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R64	0072214	RESISTOR 4.7 MEG 1/4W 10% COMP	RCR07G475KS	01121
R65	0072077	RESISTOR 47K OHM 1/4W 10% COMP	RCR07G473KS	01121
R66	0072046	RESISTOR 18K OHM 1/4W 10% COMP	RCR07G183KS	01121
R67	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R68	0087836	POT 500 OHM 1/2W CER 3/8 SQ VERT ADJ 25T	3299W-1-501	
R69	0072014	RESISTOR 6.8K OHM 1/4W 10% COMP	RCR07G682KS	01121
R70	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R71	0072182	RESISTOR 820K OHM 1/4W 10% COMP	RCR07G824KS	01121
R72	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R73	0071907	RESISTOR 220 OHM 1/4W 10% COMP	RCR07G221KS	01121
R74	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121

CLOCK RECOVERY PWB ASSEMBLY - 304284

REG DESIG PREFIX: 4657B-A4

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
R75	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R76	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R77	0072116	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G124KS	01121
R78	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R79	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R80	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R81	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM	RN55C75R0F	
R82	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R83	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R84	0071960	RESISTOR 1.2K OHM 1/4W 10% COMP	RCR07G122KS	01121
R85	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R86	0072189	RESISTOR 1.0 MEG 1/4W 10% COMP	RCR07G105KS	01121
R87	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R88	0071862	RESISTOR 47 OHM 1/4W 10% COMP	RCR07G470KS	01121
R89	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R90	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R91	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R92	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R93	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R94	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R95	0072039	RESISTOR 15K OHM 1/4W 10% COMP	RCR07G153KS	01121
R96	0071938	RESISTOR 680 OHM 1/4W 10% COMP	RCR07G681KS	01121
R97	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R98	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R99	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R100	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R101	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R102	0087836	POT 500 OHM 1/2W CER 3/8 SQ VERT ADJ 25T	3299W-1-501	
R103	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R104	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R105	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R106	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R107	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R108	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R109	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R110	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R111	0072182	RESISTOR 820K OHM 1/4W 10% COMP	RCR07G824KS	01121
R112	0071901	RESISTOR 180 OHM 1/4W 10% COMP	RCR07G181KS	01121
R113	0071894	RESISTOR 120 OHM 1/4W 10% COMP	RCR07G121KS	01121
R114	0085745	RESISTOR 68.1 OHM RN55C 1% MTL FLM	RN55C68R1F	
R115	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KA	01121
R116	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R117	0071907	RESISTOR 220 OHM 1/4W 10% COMP	RCR07G221KS	01121
R118	0071926	RESISTOR 470 OHM 1/4W 10% COMP	RCR07G471KS	01121
R119	0085745	RESISTOR 68.1 OHM RN55C 1% MTL FLM	RN55C68R1F	
R120	0071951	RESISTOR 1.0 OHM 1/4W 10% COMP	RCR07G102KS	01121
R121	0071931	RESISTOR 560 OHM 1/4W 10% COMP	RCR07G561KS	01121
R122	0071907	RESISTOR 220 OHM 1/4W 10% COMP	RCR07G221KS	01121
R123	0071926	RESISTOR 470 OHM 1/4W 10% COMP	RCR07G471KS	01121
R124	0071926	RESISTOR 470 OHM 1/4W 10% COMP	RCR07G471KS	01121
R125	0071913	RESISTOR 270 OHM 1/4W 10% COMP	RCR07G271KS	01121
R126	0071879	RESISTOR 82 OHM 1/4W 10% COMP	RCR07G820KS	01121
R127	0071938	RESISTOR 680 OHM 1/4W 10% COMP	RCR07G681KS	01121
R128	0071918	RESISTOR 330 OHM 1/4W 10% COMP	RCR07G331KS	01121
R129	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM	RN55C75R0F	
R130	0071938	RESISTOR 680 OHM 1/4W 10% COMP	RCR07G681KS	01121
R131	0071938	RESISTOR 680 OHM 1/4W 10% COMP	RCR07G681KS	01121
T1	0084083	XFMR MATCHING .2-350 MHZ 50 IN 200CT OUT	T4-1	
TP1	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779
TP2	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779
TP3	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779
TP4	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779
TP5	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779
TP6	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779
TP7	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779
TP8	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	60599-1	00779

CLOCK RECOVERY PWB ASSEMBLY - 304284

REG DESIG PREFIX: 4657B-A4

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
U1	0080054	IC AMPL RF/IF/VIDED DIP IN/OUT 10L-T0100	733 HC	13715
U2	0084657	IC OSCILLATOR VCO ECL 225 MHZ 14L DIP	MC1648P	04713
U3	0086633	IC ECL LINE RECEIVER QUAD	MC10115L	
U4	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL	F10131DC	
U5	0089654	IC ECL GATE NOR/OR 2/3/2-IN TRIPLE	F10105DC	
U6	0089654	IC ECL GATE NOR/OR 2/3/2-IN TRIPLE	F10105DC	
U7	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U8	0086632	IC OP AMP 8L-DIP 70C COMP DUAL 741C	MC1458CU	
U9	0086514	IC OP AMP JFET 8L-DIP 70C COMP DUAL	TL082ACP	
U10	0173925	IC ECL MULTIPLEXER 4 TO 1 DUAL	MC10174L	
U11	0089658	IC ECL LINE RECEIVER TRIPLE	F10116DC	
U12	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR	F10102DC	
U13	0172269	IC VLTG RGLTR NEG 5.2V .5A TYP TO 220		

FRONT PANEL ASSEMBLY - 304262

REF DESIG PREFIX: 4657B-A5

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0304261	PANEL, FRONT-DS3 ERR RT ANALYZER 4657X		
2	0256282	MASK, COLON-CLOCK DISPLAY		
A1	0304265	PWB ASSY,FNT PNL ERR RT ANALYZR 4657B		
W1	0304337	CABLE ASSY DS3 INPUT-BNC MDL 4657B		
W2	0304338	CABLE ASSY DS3 INPUT-WECO MDL 4657B		

FRONT PANEL PWB ASSEMBLY - 304265

REF DESIG PREFIX: 4657B-A5A1

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0313362	PWB FRONT PANEL ERR RT ANALYZR MDL 4657B		
2	0076302	STRAP TIE DOWN RUBBER ROUND 5/64 DIA	2829-75-4	98159
3	0171583	SPACER .120LD .187 OD .240 L NYLON LED	908-240	
C1	0081101	CAPACITR 1 MF 50V CER MONO 20%	8131-050-651-105M	72982
C2	0175327	CAPACITR 4700 MF 16V RDL SLD	16T472M18X40	
C3	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C6	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
CR1	0171565	LAMP LED YEL .115 DIA .135 LNG 2.2V 10MA	HLMP-1402	
CR9	0174624	LAMP LED RED .115 DIA .135 LNG 2.2V 10MA	HLMP-1302	
CR10	0174624	LAMP LED RED .115 DIA .135 LNG 2.2V 10MA	HLMP-1302	
CR11	0174624	LAMP LED RED .115 DIA .135 LNG 2.2V 10MA	HLMP-1302	
CR12	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA	HLMP-1523	
CR13	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA	HLMP-1523	
CR14	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA	HLMP-1523	
CR17	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA	HLMP-1523	
CR27	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA	HLMP-1523	
CR28	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA	HLMP-1523	
CR32	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA	HLMP-1523	
CR33	0171536	LAMP LED YEL.122 DIA .110 LNG 2.1V 20MA	MV5377C	
CR34	0171565	LAMP LED YEL .115 DIA .135 LNG 2.2V 10MA	HLMP-1402	
J1	0173951	CONN COAX BNC FEM PC MT .87 LG.		
J2	0173951	CONN COAX BNC FEM PC MT .87 LG.		
J3	0173951	CONN COAX BNC FEM PC MT .87 LG.		
J4	0173951	CONN COAX BNC FEM PC MT .87 LG.		
J5	0173951	CONN COAX BNC FEM PC MT .87 LG.		
J6	0173951	CONN COAX BNC FEM PC MT .87 LG.		
J7	0173951	CONN COAX BNC FEM PC MT .87 LG.		
L1	0081740	INDUCTOR 250 UH FILTER CHOKE 1.3A	6310-9	04213
Q1	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	2N6427	04713
Q2	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	2N6427	04713
Q3	0078214	TRANSSTR 2N5087 PNP SIL	2N5087	04713
Q4	0078600	NOT ASSIGNED		
Q5	0078600	NOT ASSIGNED		
R1	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R2	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R3	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R4	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R5	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R6	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R7	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R8	0076274	RESISTOR 18 OHM 1/4W 10% COMP	RCR07G180KS	01121
R9	0071913	RESISTOR 270 OHM 1/4W 10% COMP	RCR07G271KS	01121
R10	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R11	0071926	RESISTOR 470 OHM 1/4W 10% COMP	RCR07G471KS	01121
R12	0072113	RESISTOR 100K OHM 1/4W 10% COMP	RCR07G104KS	01121
R13	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	RCR07G332KS	01121
R14	0078600	NOT ASSIGNED		
R15	0078600	NOT ASSIGNED		
S1	0174607	SWITCH PUSHB SPDT MOM BLU BTN 1RED 1GRN	SEAUOA0703GR	
S2	0174601	SWITCH PUSHB SPDT MOM BLK BUTTON	SEAUOA0101	
S3	0174606	SWITCH PUSHB SPDT MOM BLU BTN 2 GRN LEDS	SEAUOA0703GG	
S4	0174606	SWITCH PUSHB SPDT MOM BLU BTN 2 GRN LEDS	SEAUOA0703GG	
S5	0174606	SWITCH PUSHB SPDT MOM BLU BTN 2 GRN LEDS	SEAUOA0703GG	
S6	0174606	SWITCH PUSHB SPDT MOM BLU BTN 2 GRN LEDS	SEAUOA0703GG	
S7	0174604	SWITCH PUSHB SPDT MOM BLK BTN 2 GRN LEDS	SEAUOA0103GG	
S8	0174604	SWITCH PUSHB SPDT MOM BLK BTN 2 GRN LEDS	SEAUOA0103GG	
S9	0174601	SWITCH PUSHB SPDT MOM BLK BUTTON	SEAUOA0101	
S10	0172481	SWITCH,PUSHB SPDT MOM,BLK BUTTON,GRN LED		

FRONT PANEL PWB ASSEMBLY - 304265

REF DESIG PREFIX: 4657B-A5A1

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
S11	0172481	SWITCH,PUSHB SPDT MOM,BLK BUTTON,GRN LED		
S12	0174605	SWITCH PUSHB SPDT MOM BLU BTN GRN LED	SEAUOA0702G	
S13	0174606	SWITCH PUSHB SPDT MOM BLU BTN 2 GRN LEDS	SEAUOA0703GG	
S14	0174604	SWITCH PUSHB SPDT MOM BLK BTN 2 GRN LEDS	SEAUOA0103GG	
S15	0174602	SWITCH PUSHB SPDT MOM RED BUTTON	SEAUOA0102Y	
S16	0174604	SWITCH PUSHB SPDT MOM BLK BTN 2 GRN LEDS	SEAUOA0103GG	
S17	0174604	SWITCH PUSHB SPDT MOM BLK BTN 2 GRN LEDS	SEAUOA0103GG	
S18	0174603	SWITCH PUSHB SPDT MOM BLK BTN YEL LED		
U1	0173928	IC TRANSSTR ARRAY 4-PNP 2N2907A FAMILY	TPQ2907A	
U2	0173928	IC TRANSSTR ARRAY 4-PNP 2N2907A FAMILY	TPQ2907A	
U3	0173929	IC TRANSSTR ARRAY 8-DARL PRS	ULN2813A	
U4	0088582	LAMP LED LIGHT BAR 2-SECT RED	HLMP-2300	
U5	0088582	LAMP LED LIGHT BAR 2-SECT RED	HLMP-2300	
U6	0173929	IC TRANSSTR ARRAY 8-DARL PRS	ULN2813A	
U7	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U8	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U9	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U10	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U11	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U12	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U13	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U14	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U15	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U16	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U17	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U18	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U19	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.	HDSP-3733	
U20	0173959	RESISTOR NETWORK 5 180 OHM 2% 6 SIP		
XA1P1	0087038	CONN HEADER DBL ROW STRAIGHT 50-PIN PC	2-87215-5	
XA1P2	0087038	CONN HEADER DBL ROW STRAIGHT 50-PIN PC	2-87215-5	
XA2P1	0087038	CONN HEADER DBL ROW STRAIGHT 50-PIN PC	2-87215-5	
XA3P1	0087878	CONN HEADER DBL ROW STRAIGHT 40-PIN PC	2-87215-0	

OPTIONAL RS-232C INTERFACE PWB ASSEMBLY - 304278

REF DESIG PREFIX: 4657B-A6

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0304365	PWB RS-232C INTFC MDL 4657B		
2	0084646	CONN SCREWLOCK ASSY FEMALE	205817-1	00779
C1	0035654	CAPACITR 10 MF 25V SOLID TANT POL 10%	T362B106K025AS	05397
C2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C3	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C6	0035654	CAPACITR 10 MF 25V SOLID TANT POL 10%	T362B106K025AS	05397
C7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C9	0035654	CAPACITR 10 MF 25V SOLID TANT POL 10%	T362B106K025AS	05397
C10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C11	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C12	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	DD391	71590
C13	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C14	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	DD391	71590
C15	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C16	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	DD391	71590
C17	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C18	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	DD391	71590
C19	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C20	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C21	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C22	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
J2	0087378	CONN HEADER DBL ROW STRAIGHT 6-PIN PC	1-87215-2	
J3	0087378	CONN HEADER DBL ROW STRAIGHT 6-PIN PC	1-87215-2	
J4	0087378	CONN HEADER DBL ROW STRAIGHT 6-PIN PC	1-87215-2	
J5	0085125	CONN HEADER DBL ROW STRAIGHT 4-PIN PC	87227-2	00779
J6	0085125	CONN HEADER DBL ROW STRAIGHT 4-PIN PC	87227-2	00779
J7	0085125	CONN HEADER DBL ROW STRAIGHT 4-PIN PC	87227-2	00779
J8	0078600	NOT ASSIGNED		
J9	0173954	CONN RECT 25-COND FEMALE RT ANGLE PC MT		
J10	0087378	CONN HEADER DBL ROW STRAIGHT 6-PIN PC	1-87215-2	
J11	0087378	CONN HEADER DBL ROW STRAIGHT 6-PIN PC	1-87215-2	
J12	0087378	CONN HEADER DBL ROW STRAIGHT 6-PIN PC	1-87215-2	
P1	0087878	CONN HEADER DBL ROW STRAIGHT 40-PIN PC	2-87215-0	
P2	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P3	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P4	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P5	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P6	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P7	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P8	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P9	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P10	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P11	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P12	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P13	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P14	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P15	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
P16	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
R1	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	RCR07G332KS	01121
R2	0072034	RESISTOR 12K OHM 1/4W 10% COMP	RCR07G123KS	01121
R3	0072068	RESISTOR 39K OHM 1/4W 10% COMP	RCR07G393KS	01121
R4	0071993	RESISTOR 3.9K OHM 1/4W 10% COMP	RCR07G392KS	01121
R5	0072068	RESISTOR 39K OHM 1/4W 10% COMP	RCR07G393KS	01121
R6	0072068	RESISTOR 39K OHM 1/4W 10% COMP	RCR07G393KS	01121
R7	0071993	RESISTOR 3.9K OHM 1/4W 10% COMP	RCR07G392KS	01121
S1	0173960	SWITCH SPST 8 POS DIP RT ANGLE W/ SEAL		

OPTIONAL RS-232C INTERFACE PWB ASSEMBLY - 304278

REF DESIG PREFIX: 4657B-A6

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
U1	0170265	IC COMM INTERFACE USART PROGRAMMABLE	IP8251A	
U2	0086790	IC TIMER PROGRAMMABLE INTERVAL	8253	
U3	0087456	IC TTL MULTIPLIER RATE DECADE	SN74167N	
U4	0087087	RESISTOR NETWORK 7 10K OHM 2% 8 SIP	764-1-R10K	
U5	0089428	RESISTOR NETWORK 9 10K OHM 2% 10 SIP	4310R-101-103	
U6	0089428	RESISTOR NETWORK 9 10K OHM 2% 10 SIP	4310R-101-103	
U7	0085949	IC TTL BUFFER OCTAL 3-STATE	SN74LS244N	
U8	0087083	IC DTL LINE DRIVER QUAD	MC1488L	
U9	0087084	IC DTL LINE RECEIVER QUAD	MC1489L	
U10	0087088	RESISTOR NETWORK 7 39K OHM 2% 8 SIP	764-1-R39K	
U11	0087085	RESISTOR NETWORK 7 3.9K OHM 2% 8 SIP	764-1-R3.9K	
U12	0086644	IC TTL GATE INVERTER HEX	SN74LS05N	
U13	0087084	IC DTL LINE RECEIVER QUAD	MC1489L	
U14	0084285	IC TTL GATE OR 2-IN QUAD	SN74LS32N	01295
XU1	0086652	SOCKET 28 PIN DIP PC MT	ICT-286-S-TG30	
XU2	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	

OPTIONAL IEEE-488 INTERFACE PWB ASSEMBLY - 304281

REF DESIG PREFIX: 4657B-A6

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0304366	PWB IEEE-488 INTERFACE MDL 4657B		
C1	0035654	CAPACITR 10 MF 25V SOLID TANT POL 10%	T362B106K025AS	05397
C2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C3	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C6	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C7	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C8	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C9	0084214	CAPACITR .0015 MF 100V CER MONO X7R 10%	8121-100-X7R-152K	72982
C10	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	8121-100-X7R-102K	72982
C11	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	DD391	71590
C12	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	DD391	71590
C13	0081252	CAPACITR 120PF 1KV CER DISC S3N 10%	DD121	71590
J1	0078600	NOT ASSIGNED		
J2	0173933	CONNECTR 24 PIN DOUBLE READOUT RT ANGLE	552791-1	
J3	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	87220-2	
L1	0078716	INDUCTOR 100 UH SUBMIN UNSHLD 10%	IR-2	91637
L2	0078716	INDUCTOR 100 UH SUBMIN UNSHLD 10%	IR-2	91637
P1	0087878	CONN HEADER DBL ROW STRAIGHT 40-PIN PC	2-87215-0	
P3	0086884	JUMPER FEMALE INSULATED .10 SPACING	65474-004	
Q1	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
Q2	0077147	TRANSSTR 2N3947 NPN SIL	2N3947	04713
Q3	0079490	TRANSSTR 2N2369A NPN SIL SWITCHING	2N2369A	79089
Q4	0079490	TRANSSTR 2N2369A NPN SIL SWITCHING	2N2369A	79089
R1	0072054	RESISTOR 22K OHM 1/4W 10% COMP	RCR07G223KS	01121
R2	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R3	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R4	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	RCR07G152KS	01121
R5	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R6	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R7	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	RCR07G222KS	01121
R8	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	RCR07G332KS	01121
R9	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R10	0072026	RESISTOR 10K OHM 1/4W 10% COMP	RCR07G103KS	01121
R11	0071973	RESISTOR 1.8K OHM 1/4W 10% COMP	RCR07G182KS	01121
S1	0173960	SWITCH SPST 8 POS DIP RT ANGLE W/ SEAL		
U1	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE	MC3448P	
U2	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE	MC3448P	
U3	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE	MC3448P	
U4	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE	MC3448P	
U5	0086900	IC BUS TRANSCVR IEEE 488 INTERFACE	MC68488L	
U6	0085949	IC TTL BUFFER OCTAL 3-STATE	SN74LS244N	
U7	0086644	IC TTL GATE INVERTER HEX	SN74LS05N	
U8	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	SN74LS74AN	01295
U9	0084284	IC TTL GATE NOR 3-IN TRIPLE	SN74LS27N	01295
U10	0086899	RESISTOR NETWORK 9 3.3K OHM 2% 10 SIP	785-1-R3.3K	
U11	0084279	IC TTL GATE NAND 2-IN QUAD	SN74LS00N	01295
U12	0085946	IC TTL GATE NAND 3-IN TRIPLE	SN74LS10N	
U13	0086899	RESISTOR NETWORK 9 3.3K OHM 2% 10 SIP	785-1-R3.3K	
XU5	0086653	SOCKET 40 PIN DIP PC MT	ICT-406-S-T	

REAR PANEL ASSEMBLY - 304267

REF DESIG PREFIX: 4657B-A7

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0304266	PANEL REAR-DS3 ERR RT ANALYZR MDL 4657X		
2	0079833	GUARD FINGER FAN	20049	82877
3	0256295	B SCREEN ASSY MODEL 4650		
4	0304336	POWERWIRING HARNESS MDL 4657B		
(1) B1	0076321	FAN 3 IN. SPRITE 115VAC 50/60 HZ	SU2A5	82877
B1	0317066	FAN ASSEMBLY		
(1) W1	0304339	CORD,AC FAN POWER ASSY MDL 4657B		

(1) USED ON EARLY VERISONS OF REAR PANEL ASSEMBLY.

FSCM - MANUFACTURERS CROSS REFERENCE

FSCM	Manufacturer	City	State
00779	Amp, Inc.	Harrisburg	PA
01121	Allen-Bradley Co.	Milwaukee	WI
01295	Texas Instruments, Inc.	Dallas	TX
04713	Motorola Semiconductor Pdts	Phoenix	AR
050397	Kemet Div-Union Carbide	Cleveland	OH
12040	National Semiconductor Corp.	Danbury	CN
13715	Fairchild Semiconductor Corp.	San Rafael	CA
14655	Cornell-Dubilier Elec. Corp.	S. Plainfield	NJ
15801	Fenwal Electronics	Framingham	MA
18324	Signetics Corp.	Sunnyvale	CA
24681	Memcor, Inc., Components Div /Tru-Ohm/	Huntington	IN
28480	Hewlett-Packard	Palo Alto	CA
31718	Fairchild Microwave Products	Mountain View	CA
53021	Sangamo Electric Co.	Springfield	IL
70903	Belden Manufacturing Co.	Chicago	IL
71279	Cambridge Thermionic Corp.	Cambridge	MA
71590	Centralab	Milwaukee	WI
72259	Nytronics, Inc.	Berkley Hts.	NJ
72982	Erie Resistor Corp.	Erie	PA
73138	Helipot-Div. Beckman Instr.	Fullerton	CA
74970	Johnson, E.F. Co.	Waseca	MN
75915	Littlefuse, Inc.	Des Plaines	IL
78488	Stackpole Carbon Co.-Magnet Div.	St. Marys	PA
79089	Radio Corp. of America	Harrison	NJ
80183	Sprague Pdts Co.	N. Adams	MA
80368	Sylvania Electric Pdts, Inc.	New York	NY
82877	Rotron Mfg. Co.	Woodstock	NY
91637	Dale Products, Inc.	Columbus	NE
98291	Sealectro Corp.	Mamasoneck	NY

CHAPTER 7
DIAGRAMS

INDEX

Figure	Title	Page
7.1	Analyzer Overall Assembly (Sheet 1 of 2)	7-4
7.1	Analyzer Overall Assembly (Sheet 2 of 2)	7-5
7.2	Analyzer Processor PWB (A1), Component Location	7-6
7.3	Analyzer Processor PWB (A1), Schematic (Sheet 1 of 6)	7-7
7.3	Analyzer Processor PWB (A1), Schematic (Sheet 2 of 6)	7-8
7.3	Analyzer Processor PWB (A1), Schematic (Sheet 3 of 6)	7-9
7.3	Analyzer Processor PWB (A1), Schematic (Sheet 4 of 6)	7-10
7.3	Analyzer Processor PWB (A1), Schematic (Sheet 5 of 6)	7-11
7.3	Analyzer Processor PWB (A1), Schematic (Sheet 6 of 6)	7-12
7.4	Analyzer ECL Logic PWB (A2), Component Location	7-13
7.5	Analyzer ECL Logic PWB (A2), Schematic (Sheet 1 of 5)	7-14
7.5	Analyzer ECL Logic PWB (A2), Schematic (Sheet 2 of 5)	7-15
7.5	Analyzer ECL Logic PWB (A2), Schematic (Sheet 3 of 5)	7-16
7.5	Analyzer ECL Logic PWB (A2), Schematic (Sheet 4 of 5)	7-17

Figure	Title	Page
7.5	Analyzer ECL Logic PWB (A2), Schematic (Sheet 5 of 5)	7-18
7.6	Analyzer Power Supply PWB (A3), Component Location	7-19
7.7	Analyzer Power Supply PWB (A3), Schematic (Sheet 1 of 2)	7-20
7.7	Analyzer Power Supply PWB (A3), Schematic (Sheet 2 of 2)	7-21
7.8	Analyzer Clock Recovery PWB (A4), Component Location	7-22
7.9	Analyzer Clock Recovery PWB (A4), Schematic (Sheet 1 of 3)	7-23
7.9	Analyzer Clock Recovery PWB (A4), Schematic (Sheet 2 of 3)	7-24
7.9	Analyzer Clock Recovery PWB (A4), Schematic (Sheet 3 of 3)	7-25
7.10	Analyzer Front Panel PWB (A5A1), Component Location	7-26
7.11	Analyzer Front Panel PWB (A5A1), Schematic (Sheet 1 of 2)	7-27
7.11	Analyzer Front Panel PWB (A5A1), Schematic (Sheet 2 of 2)	7-28
7.12	Analyzer Front Panel Cable Assembly (A5W1)	7-29
7.13	Analyzer Front Panel Cable Assembly (A5W2)	7-29
7.14	Analyzer Option (304278) RS-232 Interface Assembly (A6), Component Location	7-30
7.15	Analyzer Option (304278) RS-232 Interface Assembly (A6), Schematic	7-31
7.16	Analyzer Option (304281) IEEE-488 Interface Assembly (A6), Component Location	7-32
7.17	Analyzer Option (304281) IEEE-488 Interface Assembly (A6), Schematic	7-33
7.18	Analyzer Rear Panel Assembly (A7)	7-34

Figure	Title	Page
7.19	Analyzer Rear Panel Assembly (A7), Power Wiring Harness	7-35
7.20	Analyzer Rear Panel Cable Assembly (A7W1)	7-36
7.21	Analyzer Rear Panel (A7), Schematic	7-37
7.22	Model 4650 Optional Local Printer Components	7-38
7.23	Model 4650 Optional Local Printer Cable Assembly (W1)	7-38
7.24	Model 4650 Optional Local Printer Mechanical Layout	7-39
7.25	Model 4650 Optional Local Printer I/O Assembly, Component Location	7-40
7.26	Model 4650 Optional Local Printer I/O Assembly, Schematic	7-40
7.27	Model 4650 Optional Local Printer Flexible Assembly, Component Location	7-41
7.28	Model 4650 Optional Local Printer Flexible Assembly, Schematic	7-41

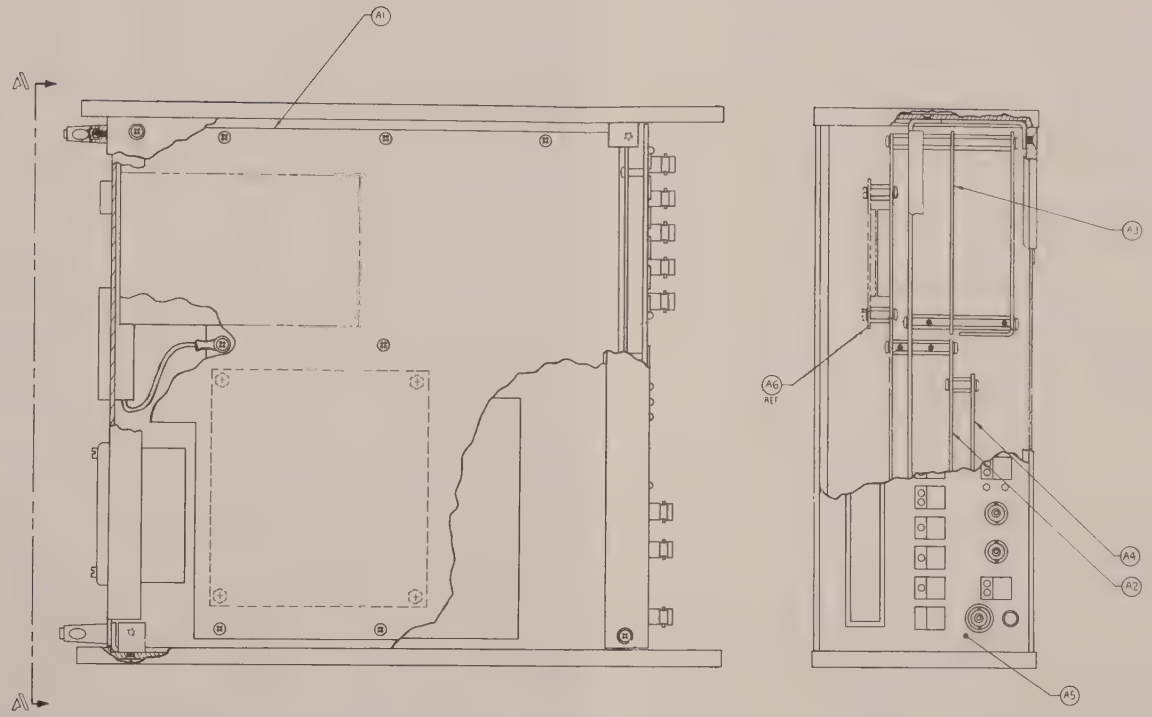
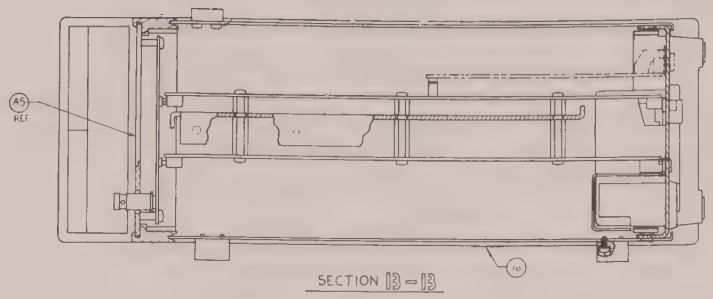
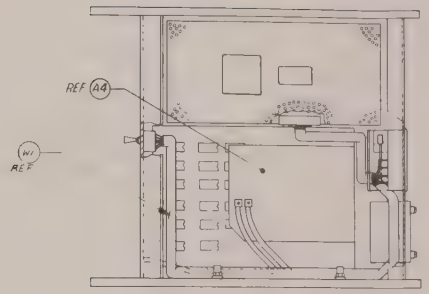
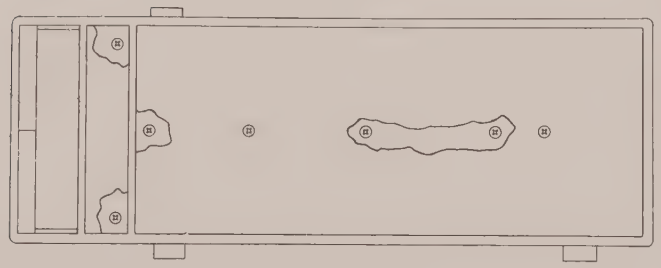


Figure 7.1. Analyzer Overall Assembly (Sheet 1 of 2)







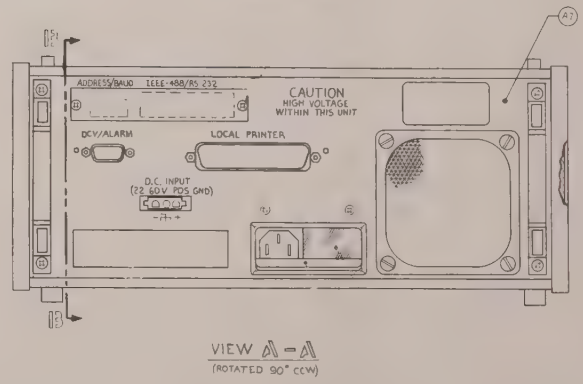
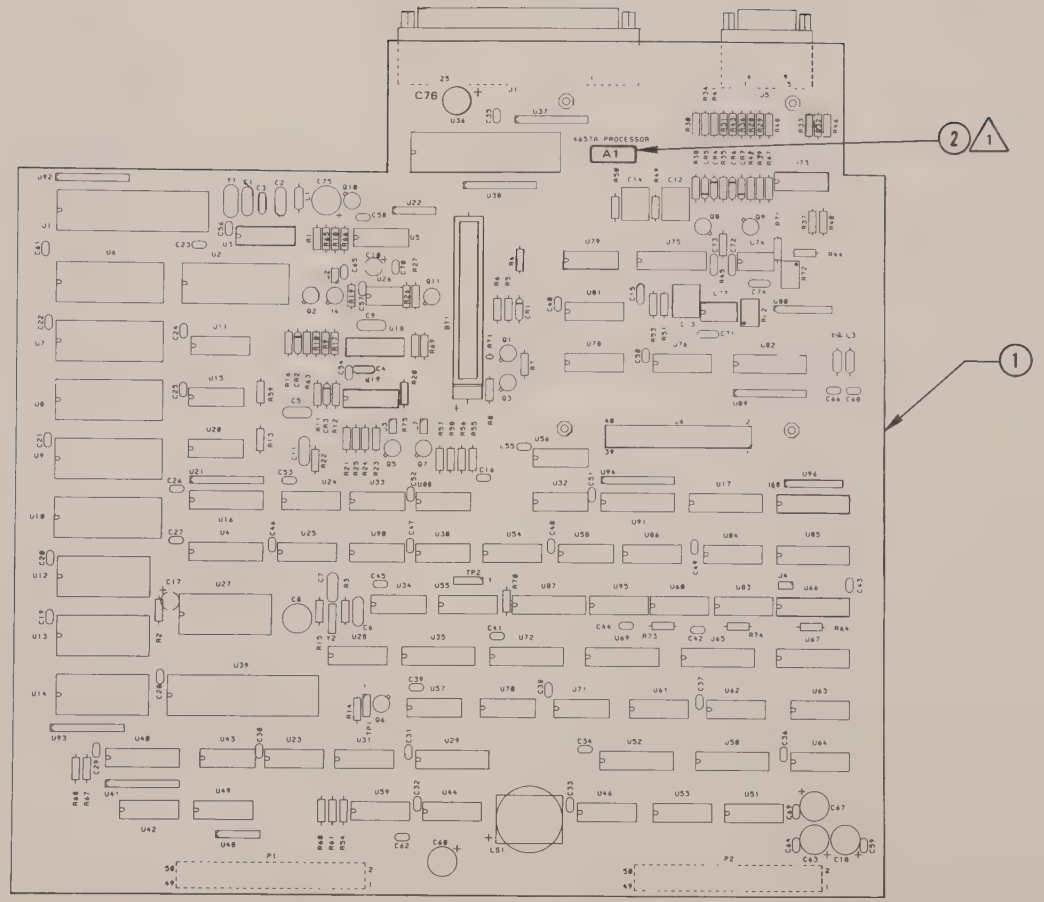


Figure 7.1. Analyzer Overall Assembly (Sheet 2 of 2)

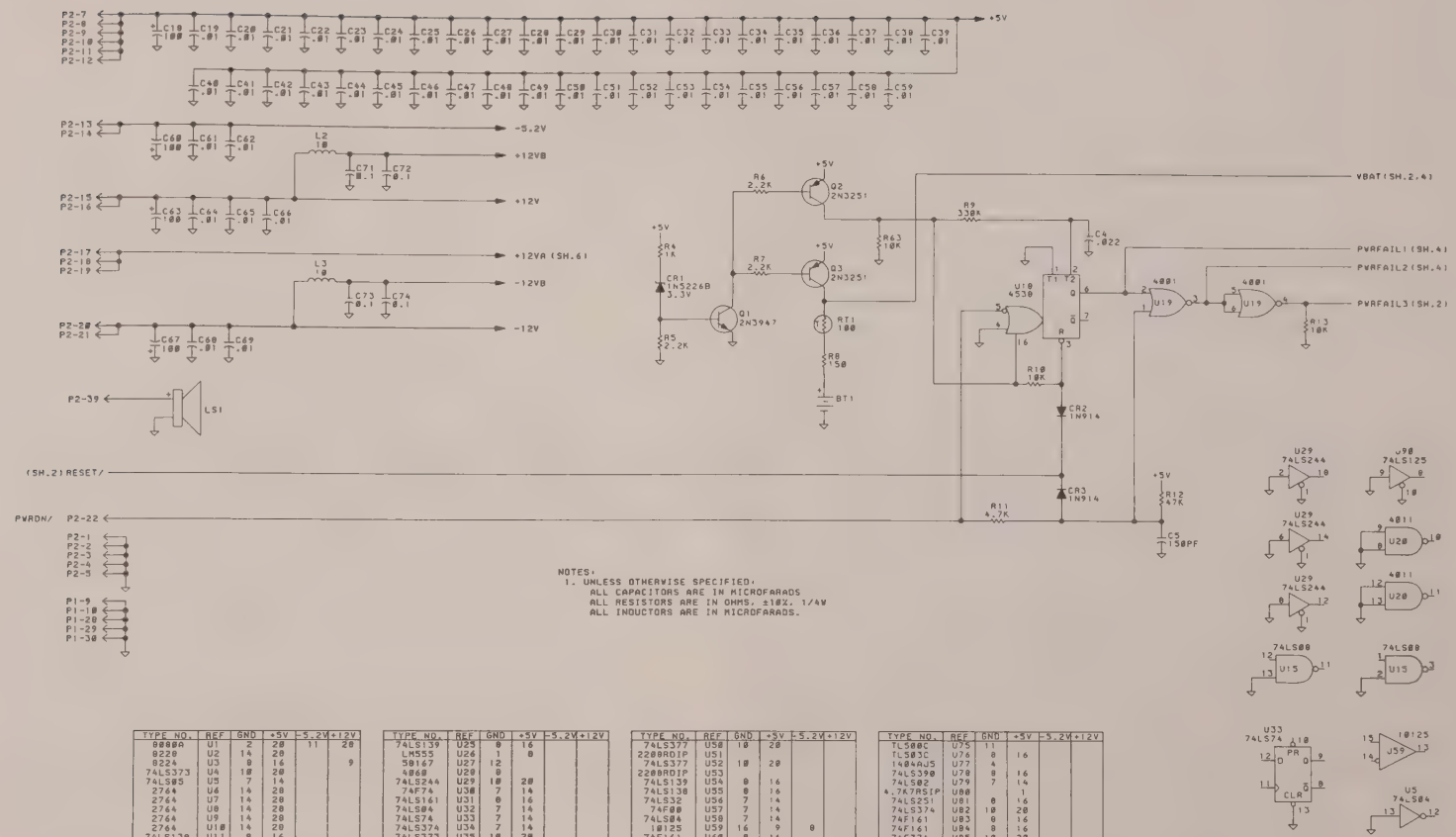


1

ASSEMBLY NUMBER	*SERIAL NUMBER	
	FROM	TO
317194	1	225
319249	226	326
317870	327	

*SERIAL NUMBERS ARE APPROXIMATE.

Figure 7.2. Analyzer Processor PWB (A1), Component Location



NOTES:
1. UNLESS OTHERWISE SPECIFIED,
   ALL CAPACITORS ARE IN MICROFARADS
   ALL RESISTORS ARE IN OHMS, ±10%, 1/4W
   ALL INDUCTORS ARE IN MICROFARADS.

TYPE NO.	REF	GND	+5V	-5.2V	+12V
8080A	U1	2	20	11	20
8228	U2	14	20		
8224	U3	8	16		9
74LS373	U4	10	20		
74LS08	U5	7	14		
2764	U6	14	20		
2764	U7	14	20		
2764	U8	14	20		
2764	U9	14	20		
2764	U10	14	20		
74LS138	U11	8	16		
6116LP	U12	12	24		
6116LP	U13	12	24		
6116LP	U14	12	1		
74LS00	U15	7	14		
74LS245	U16	10	20		
74LS245	U17	10	20		
4538	U18	1,8			
4538	U18	15			
4001	U19	7	14		
4011	U20	7			
4.7K9RSIP	U21		1		
3.3K5RSIP	U22		1		
74LS279	U23	8	16		
74LS138	U24	8	16		

TYPE NO.	REF	GND	+5V	-5.2V	+12V
74LS139	U25	8	16		
LM555	U26	1	8		
50167	U27	12			
4068	U28	8			
74LS244	U29	10	20		
74F74	U30	7	14		
74LS161	U31	8	16		
74LS04	U32	7	14		
74LS74	U33	7	14		
74LS374	U34	7	14		
74LS373	U35	10	20		
8255A	U36	7	26		
22K9RSIP	U37		1		
22K9RSIP	U38		1		
8279	U39	20	40		
74LS240	U40	10	20		
3.3K9RSIP	U41		1		
2200RDIP	U42				
74LS04	U43	7	14		
4020	U44	8	16		
4020	U46	8	16		
3.3K5RSIP	U48		1		
74LS138	U49	8	16		

TYPE NO.	REF	GND	+5V	-5.2V	+12V
74LS377	U50	10	20		
2200RDIP	U51				
74LS377	U52	10	20		
2200RDIP	U53				
74LS139	U54	8	16		
74LS138	U55	8	16		
74LS32	U56	7	14		
74F00	U57	7	14		
74LS04	U58	7	14		
10125	U59	16	9		0
74F161	U60	8	16		
74F161	U61	8	16		
74F161	U62	8	16		
74F161	U63	8	16		
74F161	U64	8	16		
74F374	U65	10	20		
74F374	U66	10	20		
74F374	U67	10	20		
74LS245	U68	10	20		
74LS377	U69	10	20		
74S140	U70	7	14		
74S140	U71	7	14		
74LS240	U72	10	20		
LM339	U73		3		
OP-07	U74				

TYPE NO.	REF	GND	+5V	-5.2V	+12V
TL500C	U75	11			
TL503C	U76	8	16		
1404AJ5	U77	4			
74LS390	U78	8	16		
74LS02	U79	7	14		
4.7K7RSIP	U80		1		
74LS251	U81	8	16		
74LS374	U82	10	20		
74F161	U83	8	16		
74F161	U84	8	16		
74F374	U85	10	20		
74F161	U86	8	16		
74F374	U87	10	20		
74S03	U88	7	14		
74LS125	U90	7	14		
74LS245	U91	10	20		
100K9RSIP	U92		1		
100K9RSIP	U93		1		
4.7K9RSIP	U94		1		
74F161	U95	8	16		
4.7K9RSIP	U96		1		

Figure 7.3. Analyzer Processor PWB (A1), Schematic (Sheet 1 of 6)

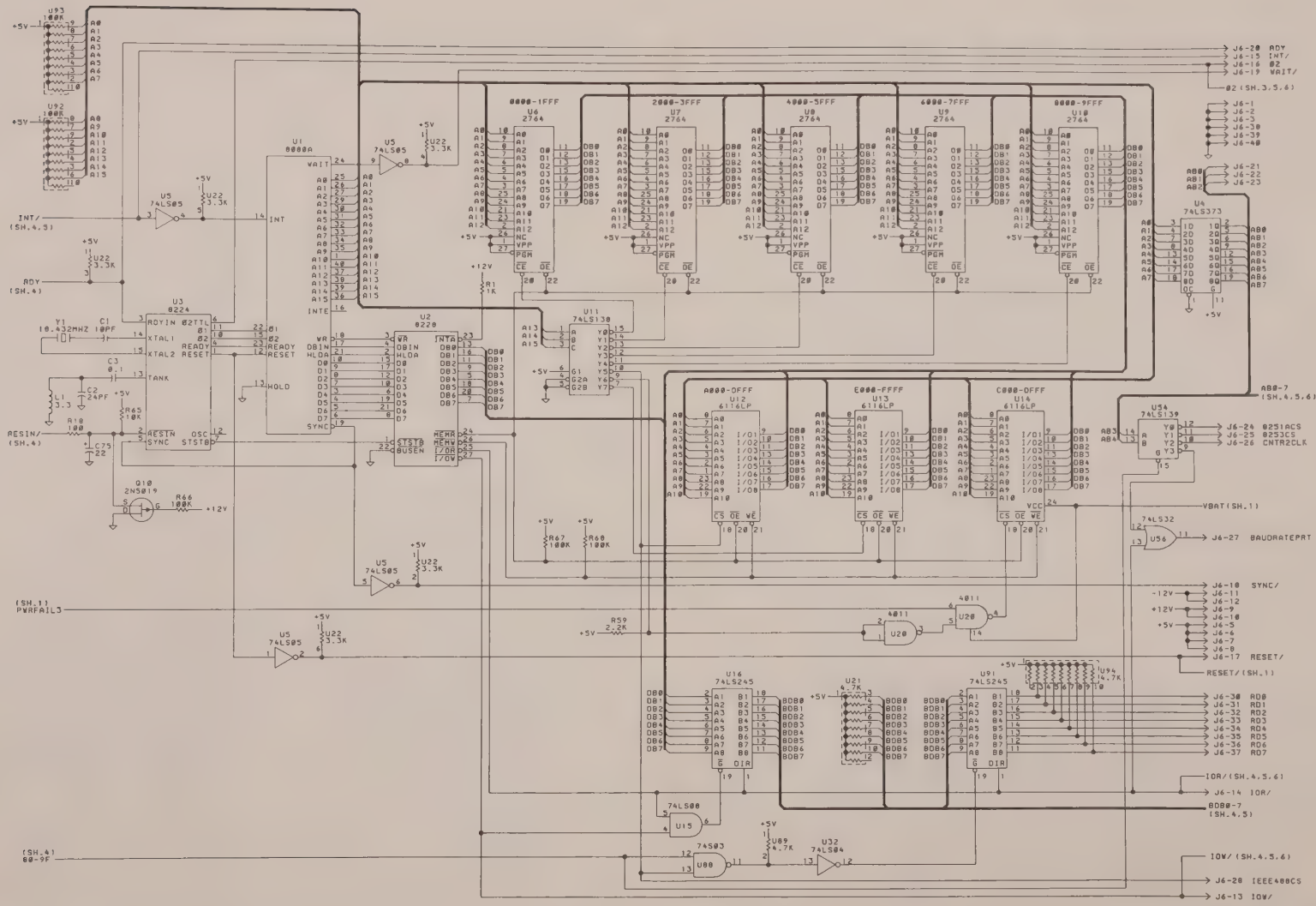


Figure 7.3. Analyzer Processor PWB (A1), Schematic (Sheet 2 of 6)

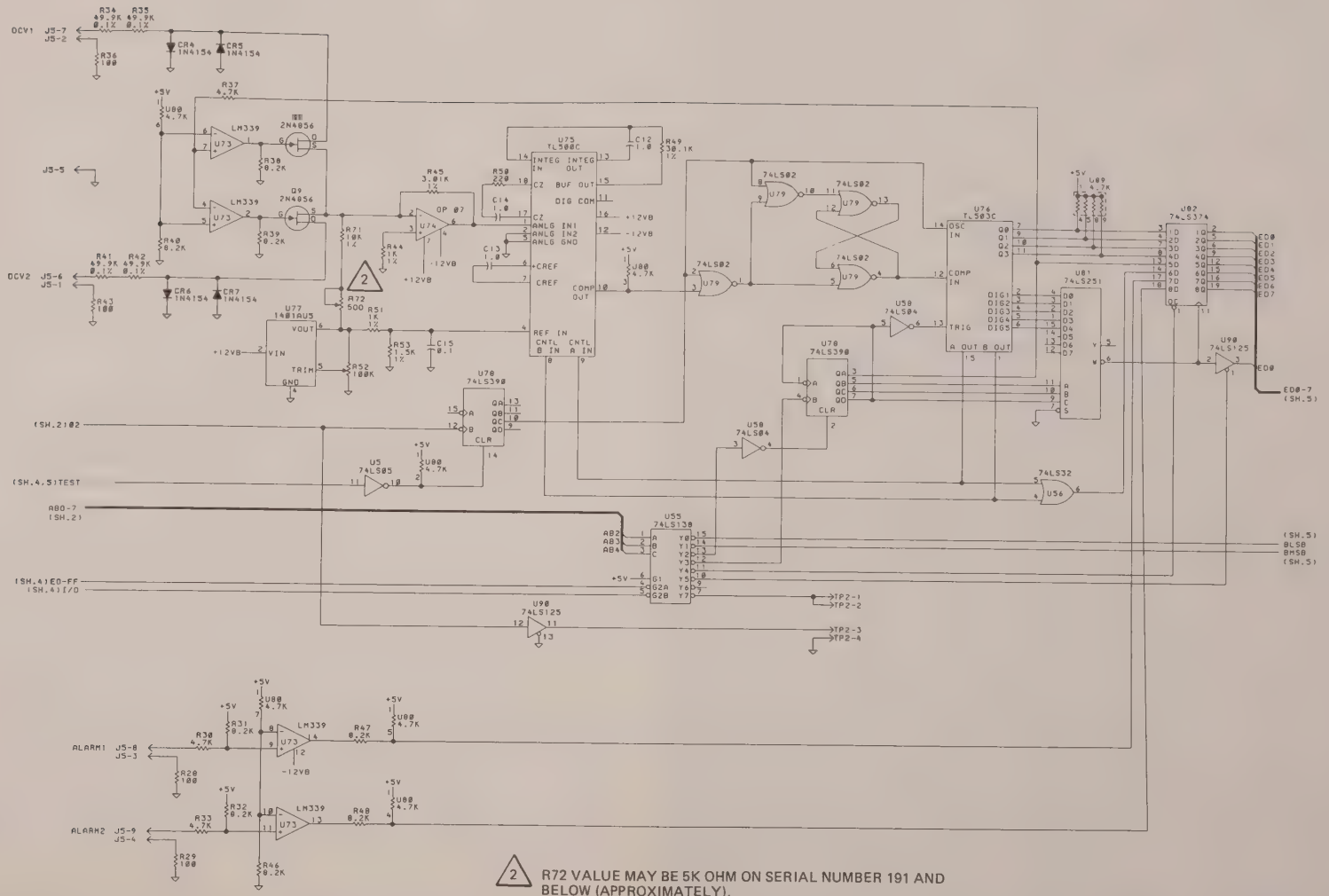


Figure 7.3. Analyzer Processor PWB (A1), Schematic (Sheet 3 of 6)

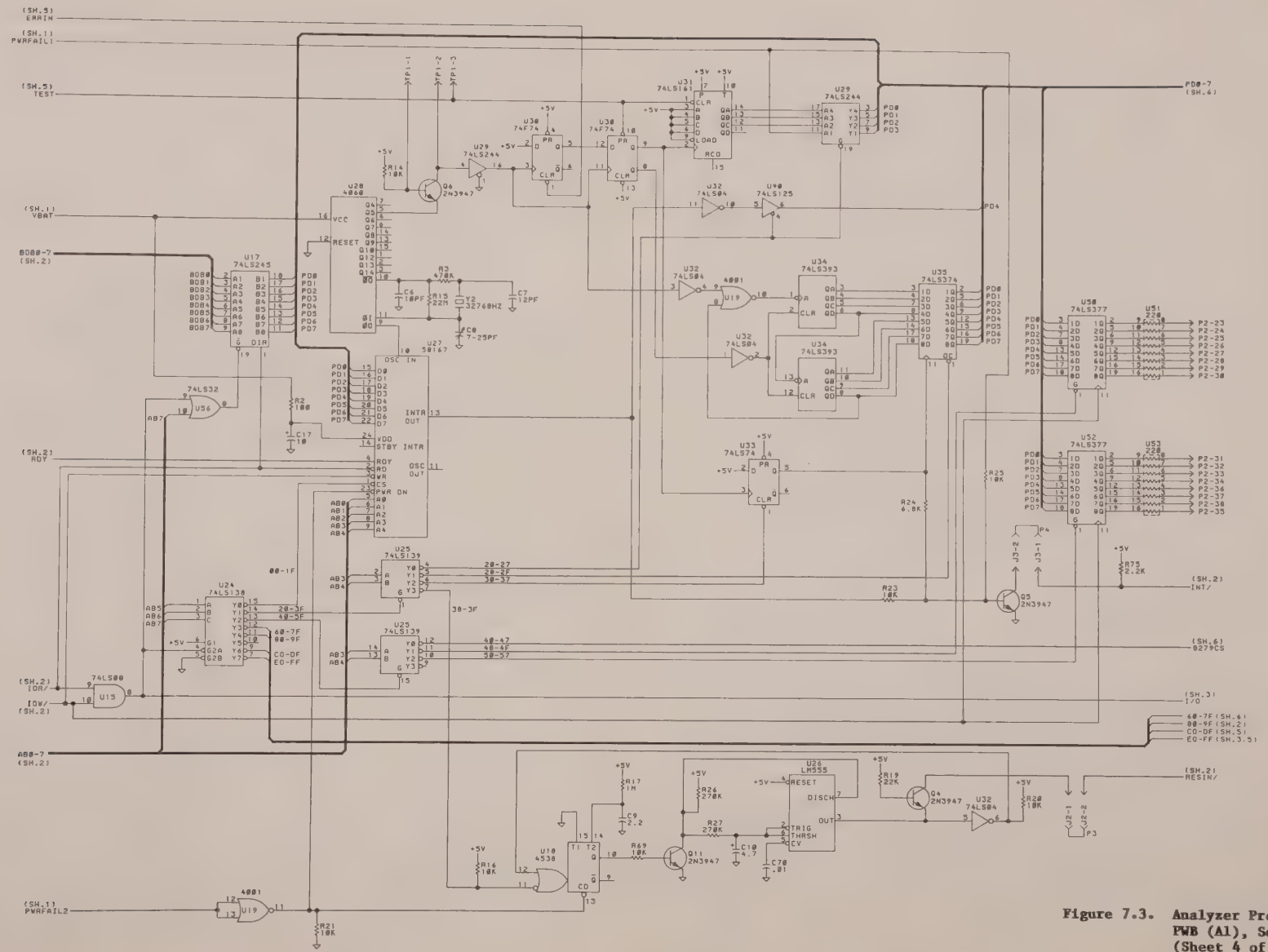


Figure 7.3. Analyzer Processor PWB (A1), Schematic (Sheet 4 of 6)

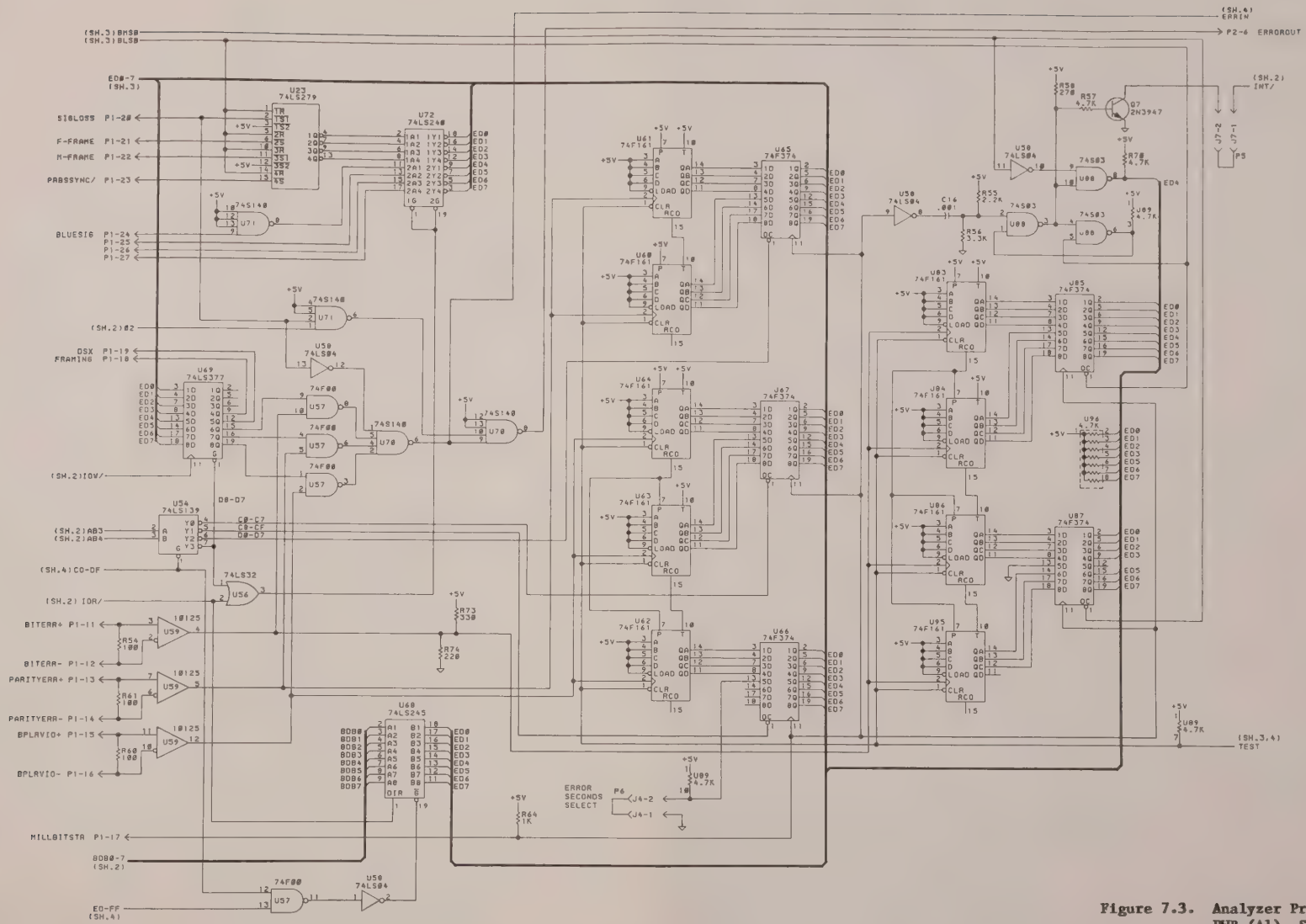


Figure 7.3. Analyzer Processor PWB (A1), Schematic (Sheet 5 of 6)

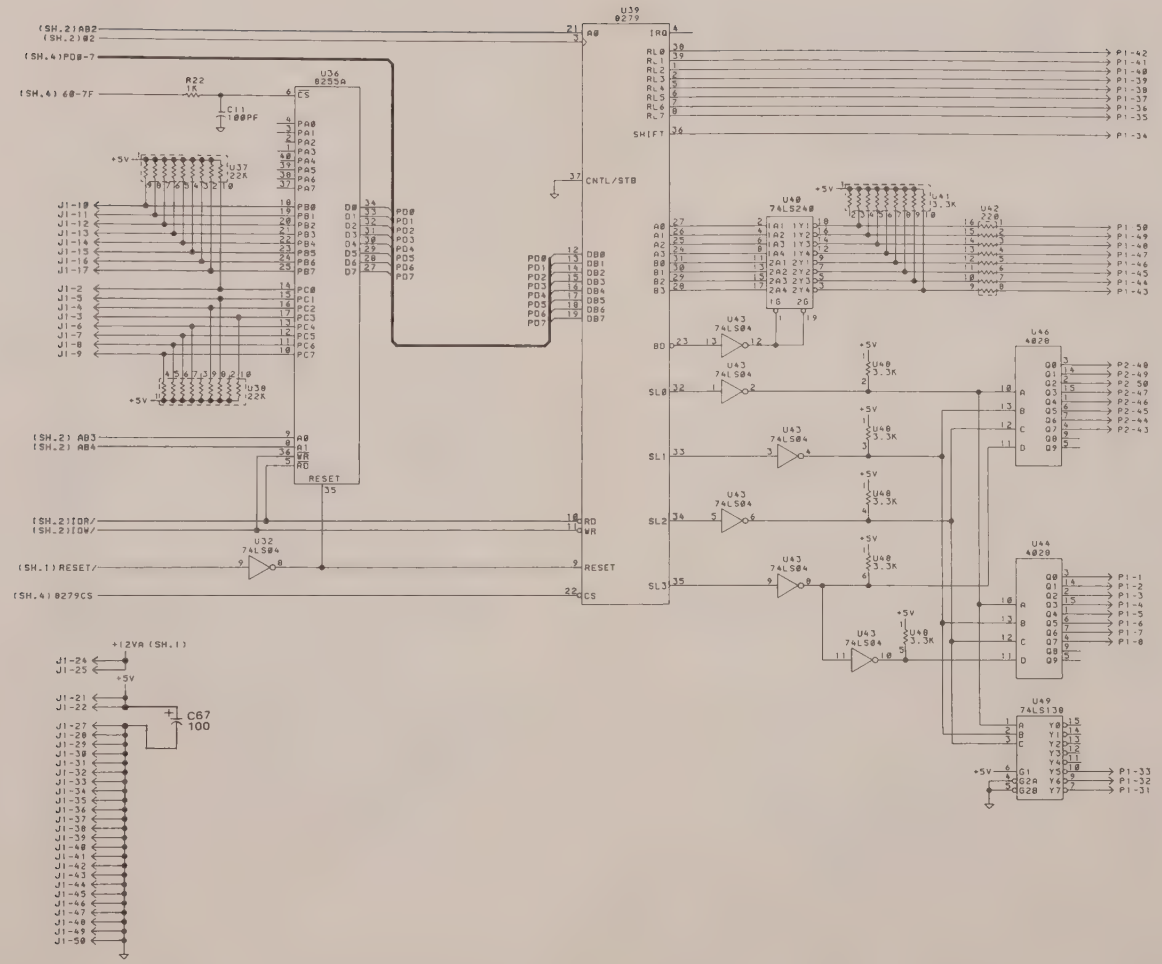
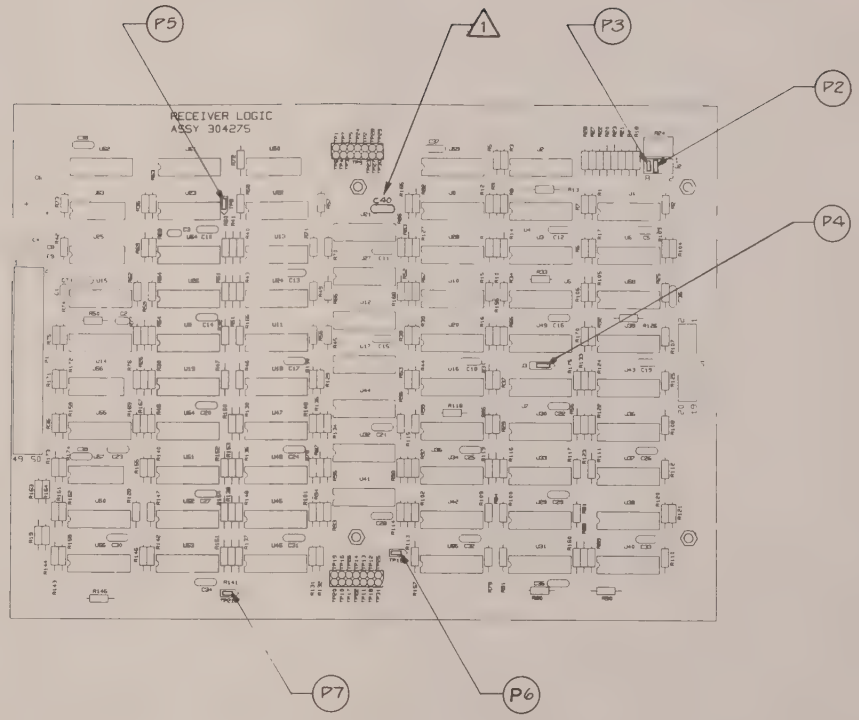


Figure 7.3. Analyzer Processor PWB (A1), Schematic (Sheet 6 of 6)



1 APPLIES TO SERIAL NUMBER 27 AND ABOVE (APPROXIMATELY).

Figure 7.4. Analyzer ECL Logic PWB (A2), Component Location

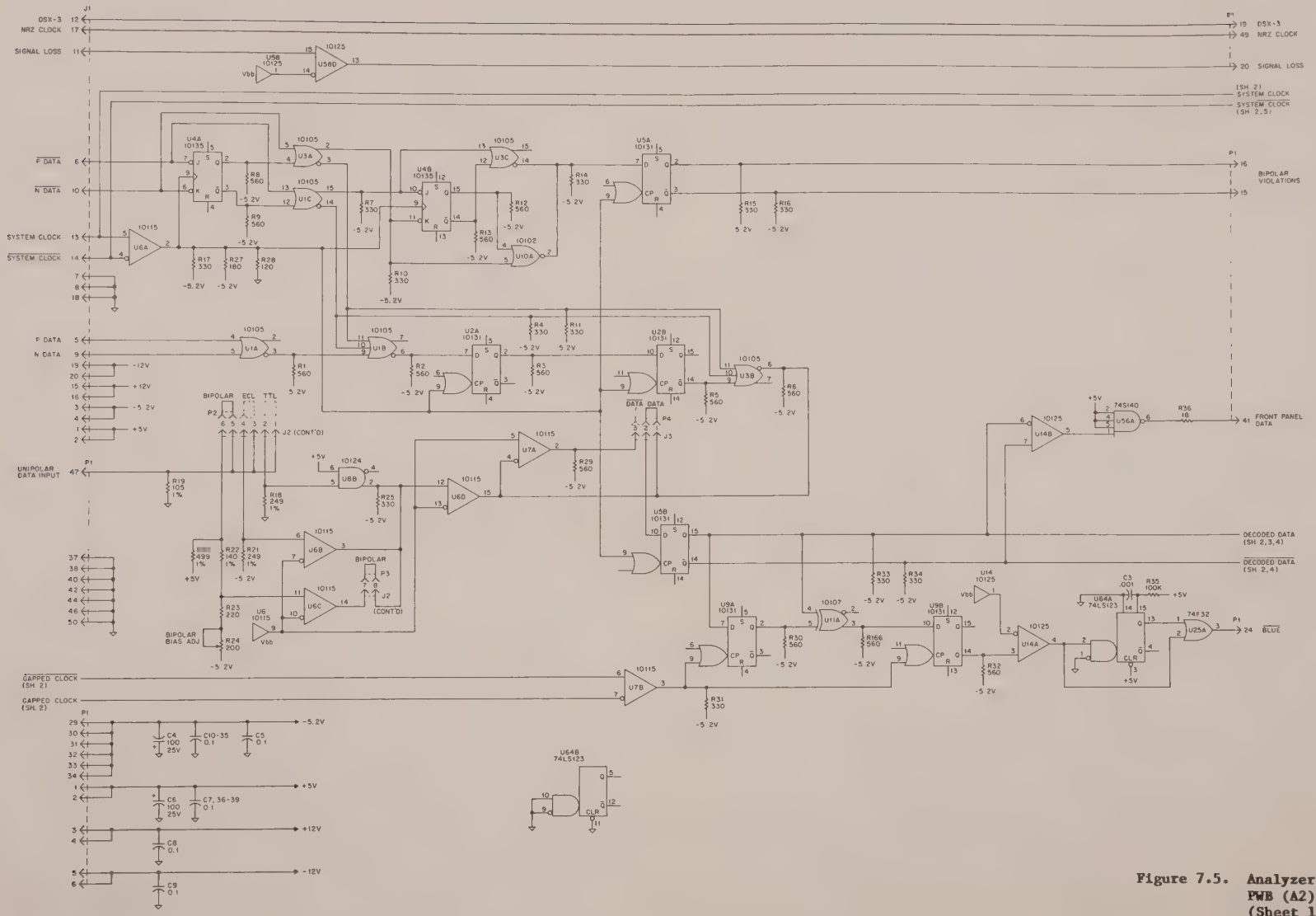


Figure 7.5. Analyzer ECL Logic PWB (A2), Schematic (Sheet 1 of 5)

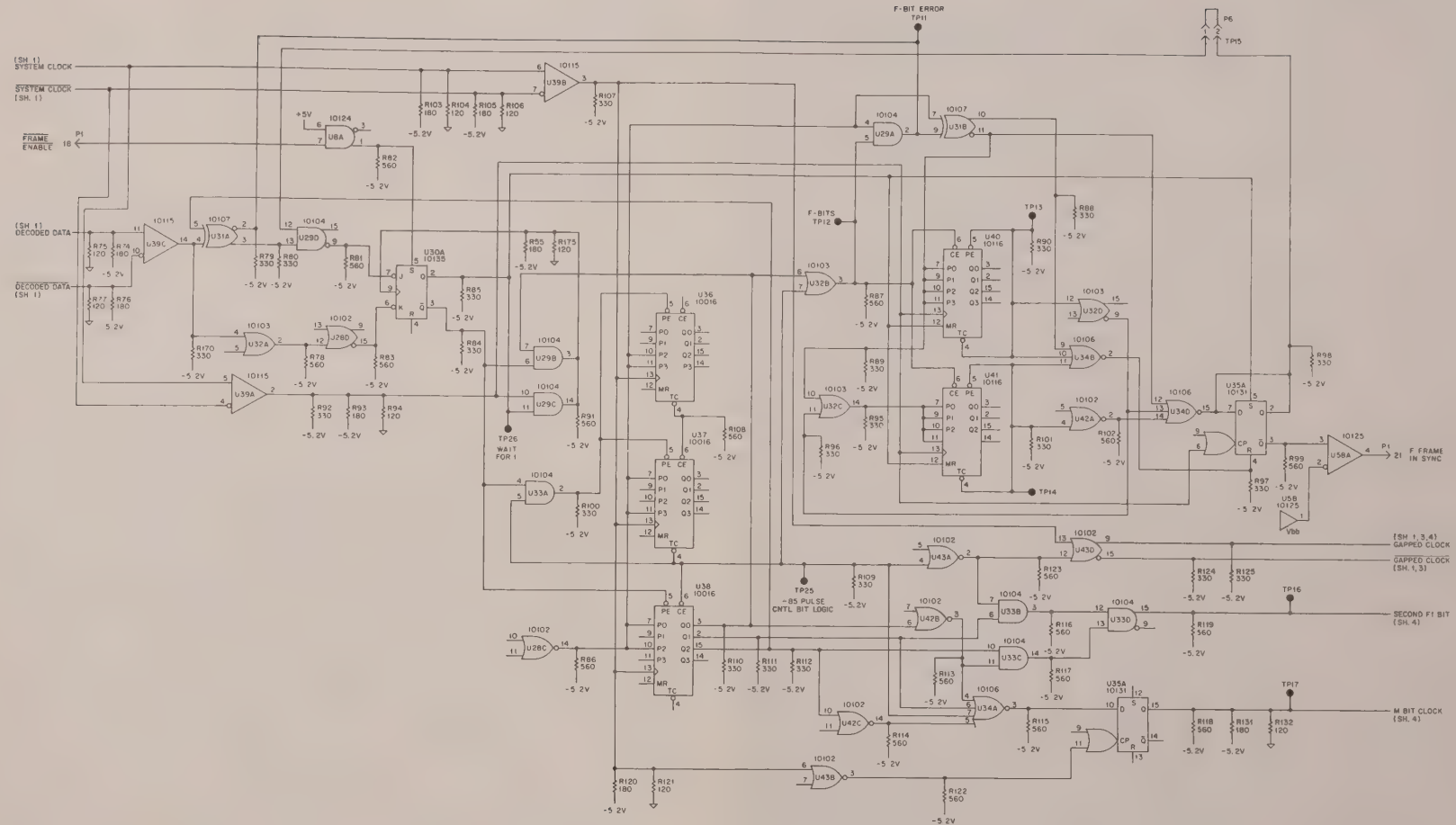
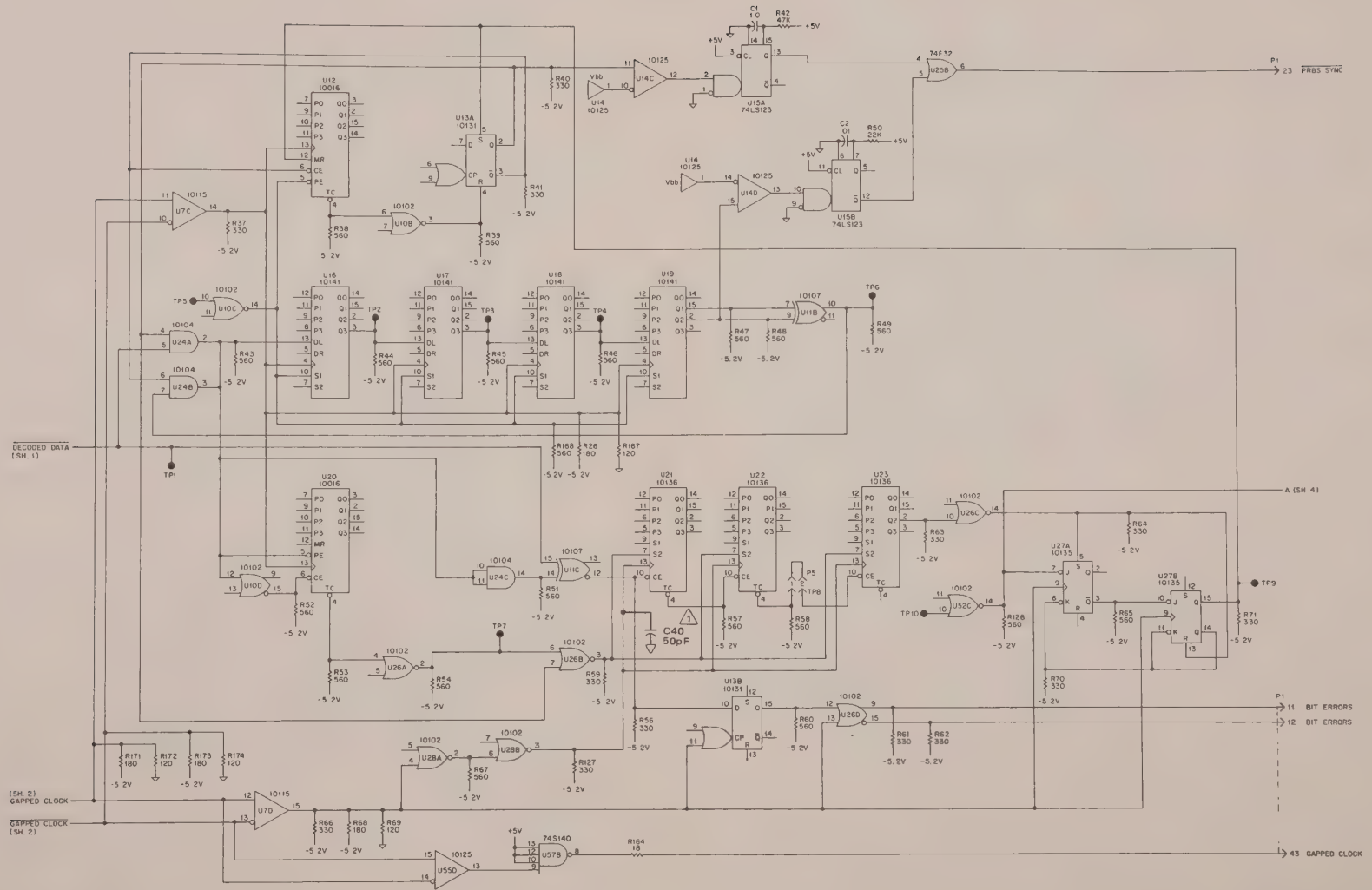


Figure 7.5. Analyzer ECL Logic PWB (A2), Schematic (Sheet 2 of 5)



⚠1 APPLIES TO SERIAL NUMBER 27 AND ABOVE (APPROXIMATELY).

Figure 7.5. Analyzer ECL Logic PWB (A2), Schematic (Sheet 3 of 5)

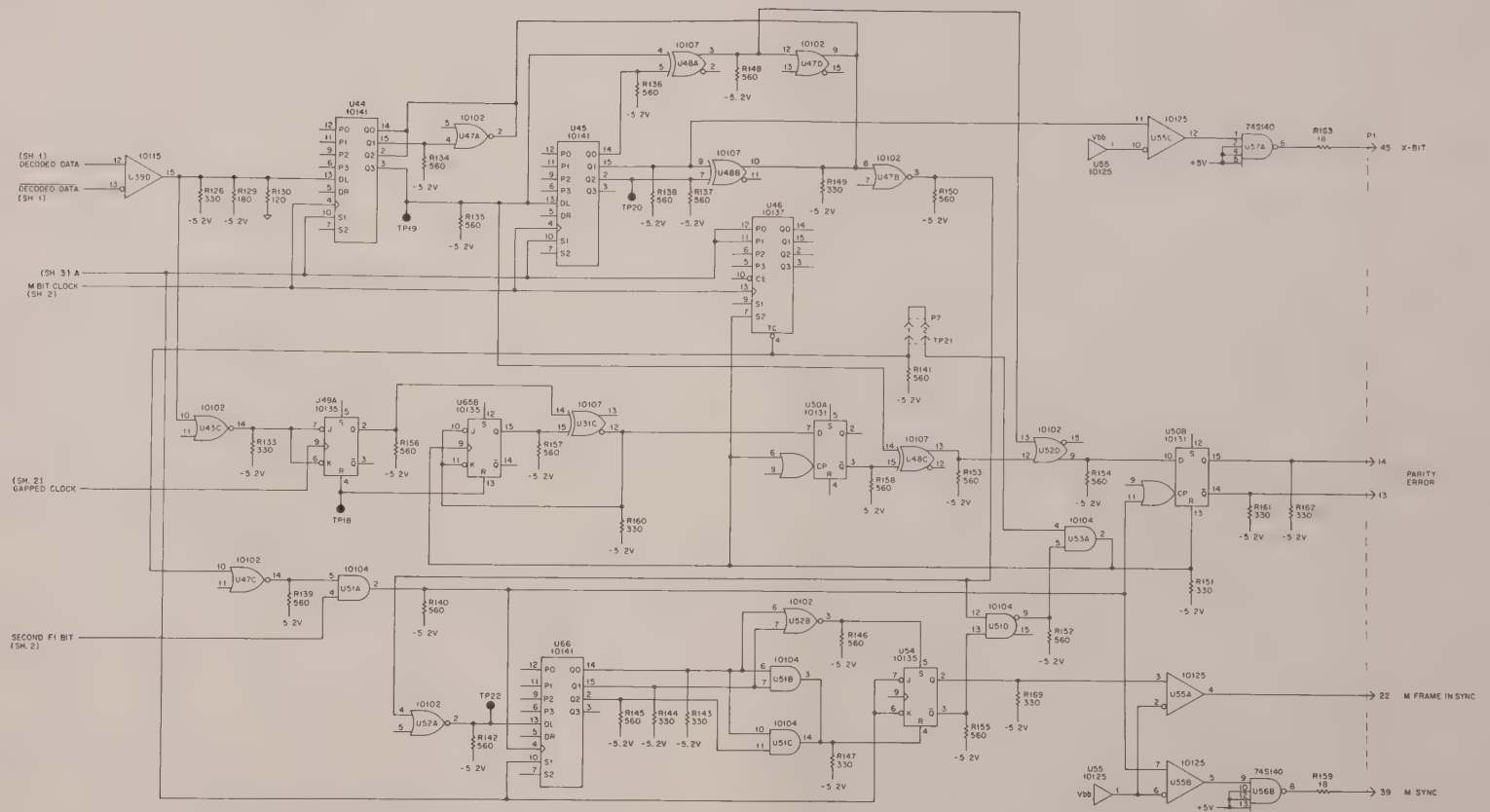
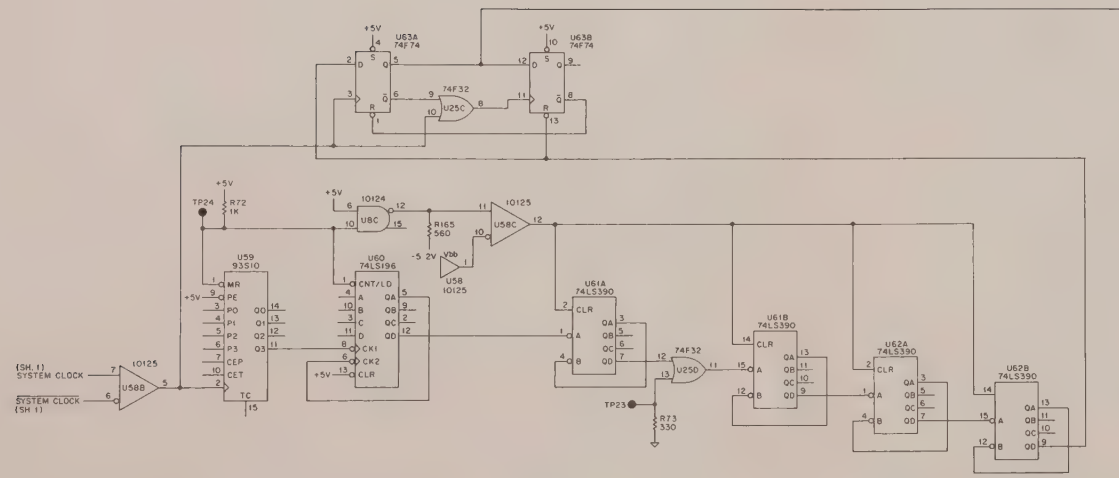
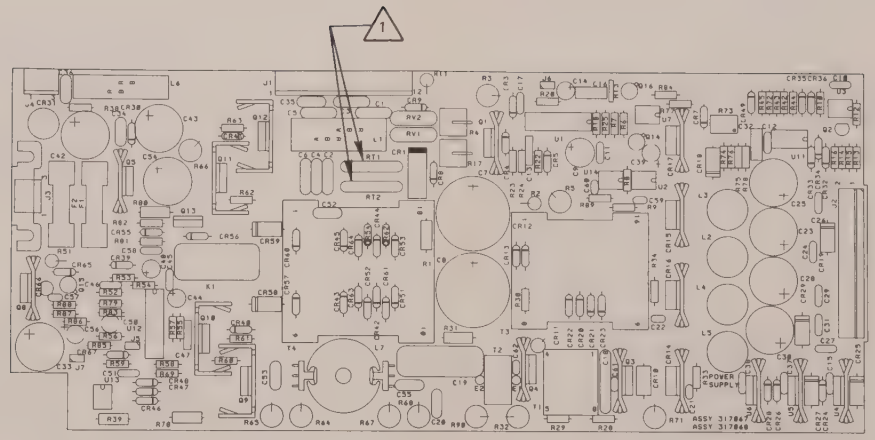


Figure 7.5. Analyzer ECL Logic PWB (A2), Schematic (Sheet 4 of 5)



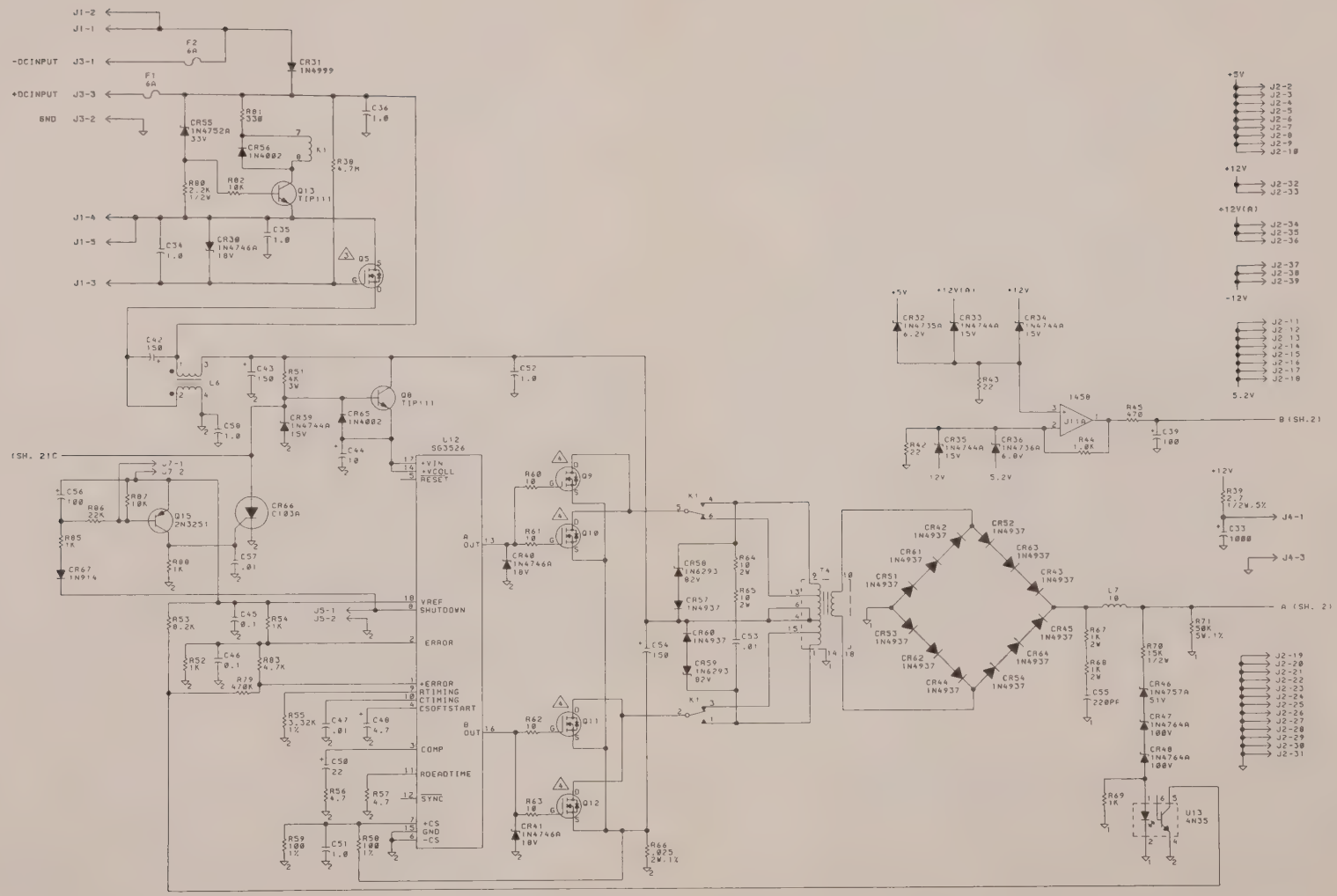
REFERENCE DESIGNATION	TYPE NUMBER	PIN NO		
		GND	+5V	-5.2V
U1,3	10105	1,16	-	8
U2,5,9,13,35,50	10131	1,16	-	8
U4,27,30,49,54,65	10135	1,16	-	8
U6,7,39	10115	1,16	-	8
U8	10124	16	9	8
U10,26,28,43,47,52	10102	1,16	-	8
U11,31,48	10107	1,16	-	8
U12,36,37,38,40,41	10016	1,16	-	8
U14,58 65	10125	16	9	8
U15	74LS123	8	16	-
U16-19,44,45,66	10141	1,16	-	8
U20,21,22,23	10136	1,16	-	8
U24,29,33,51,53,	10104	1,16	-	8
U25	74F32	7	14	-
U32,42	10103	1,16	-	8
U34	10106	1,16	-	8
U56,57	74S140	7	14	-
U59	93S10	8	16	-
U60	74LS196	7	14	-
U61,62	74LS390	8	16	-
U63	74F74	7	14	-
U64	74LS123	8	16	-
U46	10137	1,16	-	8

Figure 7.5. Analyzer ECL Logic PWB (A2), Schematic (Sheet 5 of 5)



1 DO NOT VAPOR CLEAN OR USE FREON ON RT1 AND RT2.

Figure 7.6. Analyzer Power Supply PWB (A3), Component Location



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL CAPACITORS ARE IN MICROFARADS
   ALL RESISTORS ARE IN OHMS, ±10%, 1/4W
   ALL INDUCTORS ARE IN MICROHENRIES.

2. S.A. PART NO. 313353.

3. S.A. PART NO. 313320.

4. S.A. PART NO. 313352.

5. SHOWN BUT NOT INSTALLED: C61 AND C62.

Figure 7.7. Analyzer Power Supply PWB (A3), Schematic (Sheet 1 of 2)

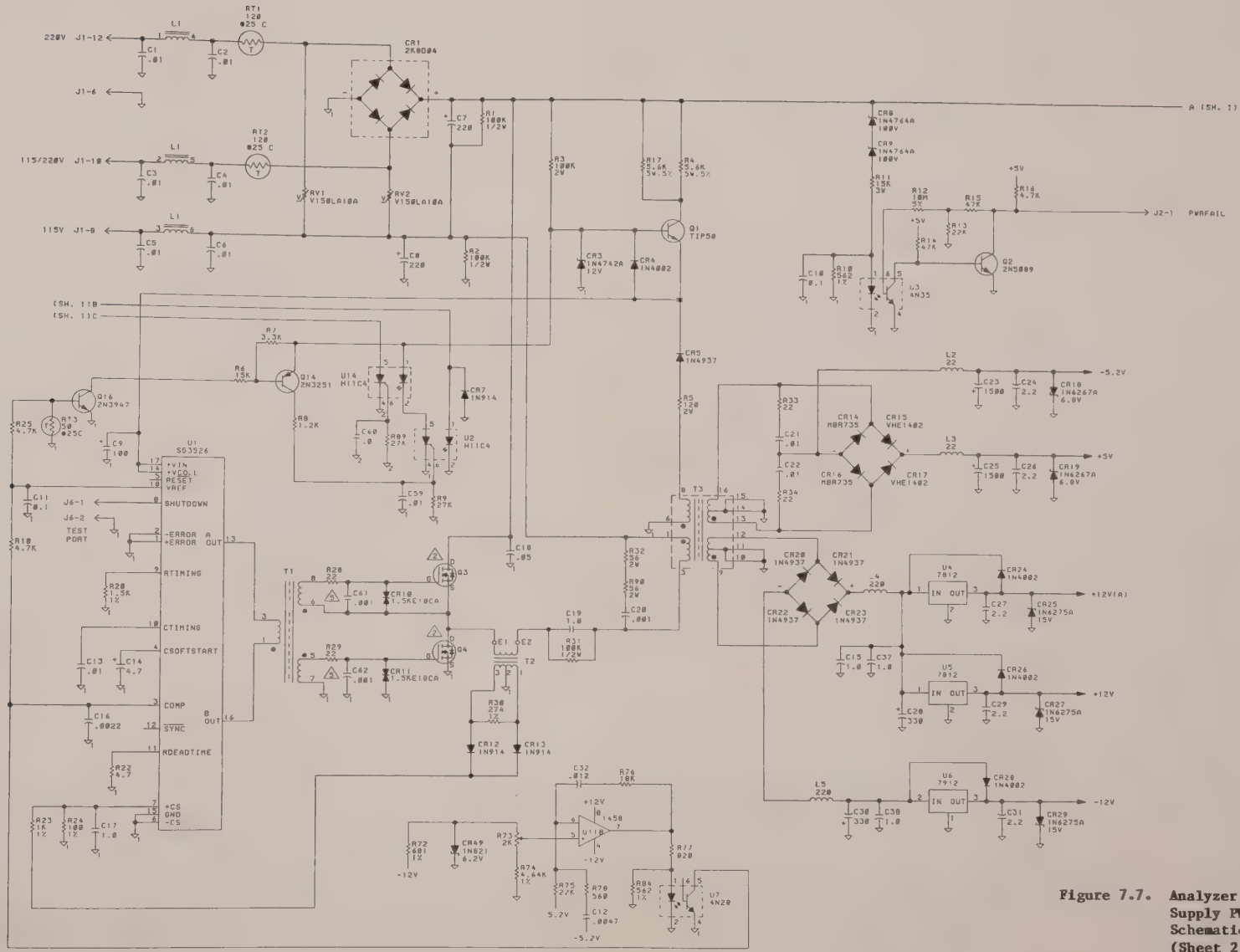
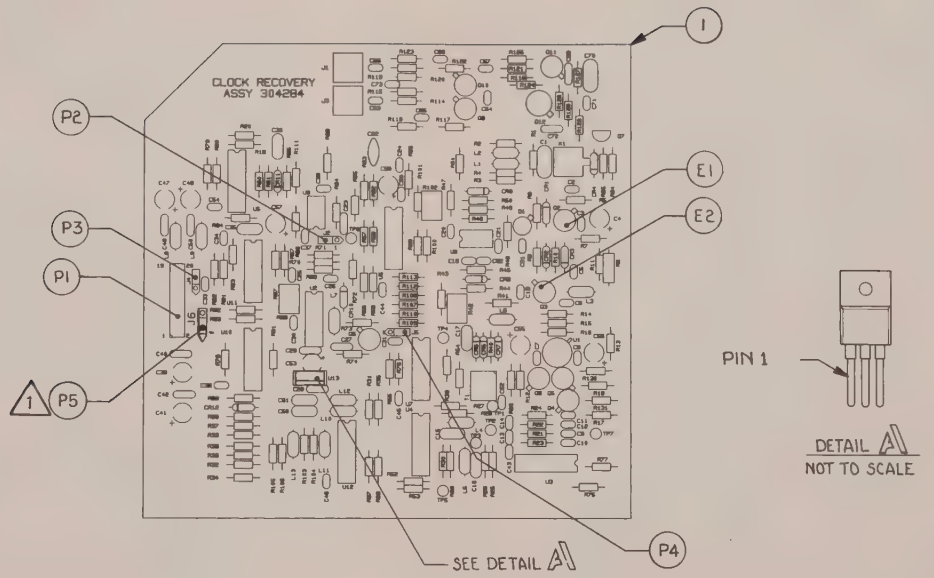
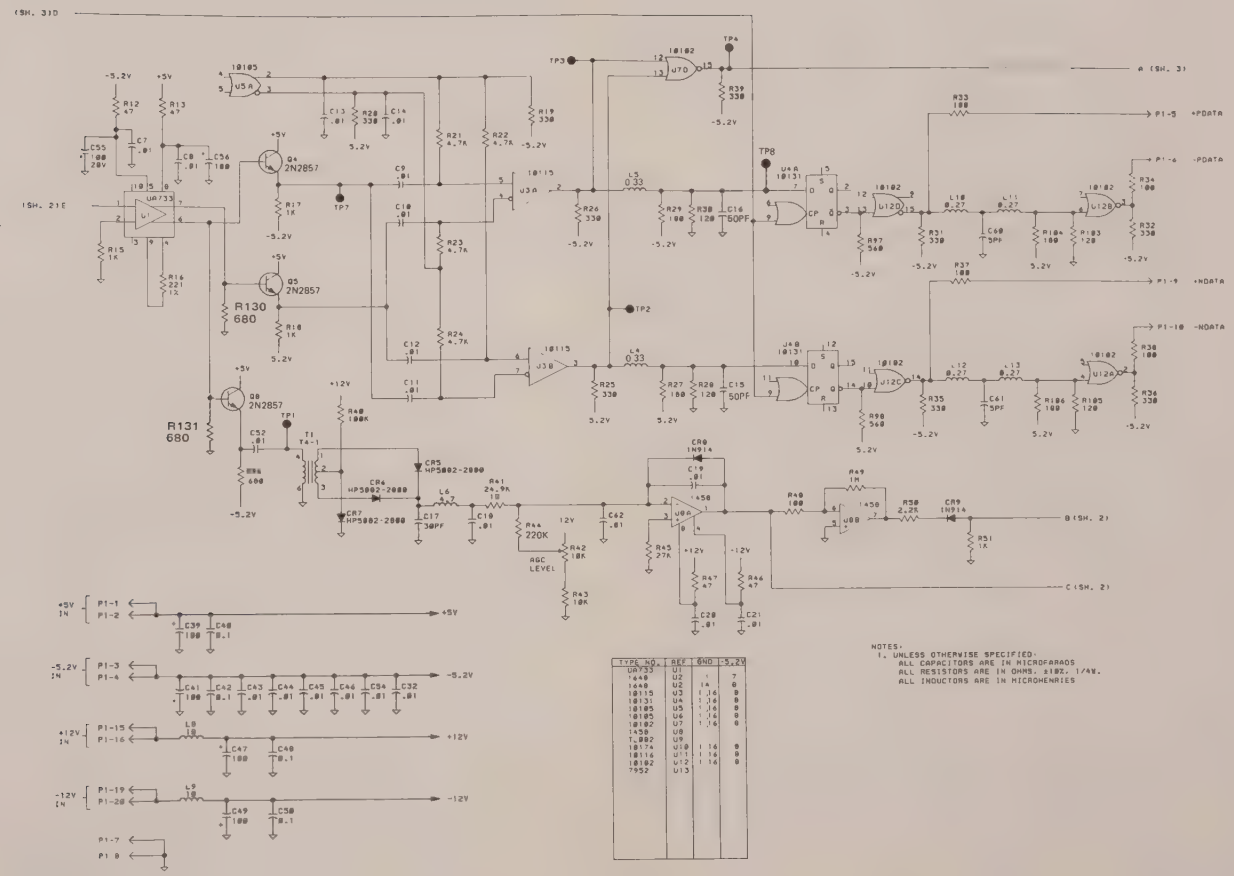


Figure 7.7. Analyzer Power Supply PWB (A3), Schematic (Sheet 2 of 2)



1 P5 AND J6 APPLIES TO UNITS WITH SERIAL NUMBER 153 AND ABOVE (APPROXIMATELY).

Figure 7.8. Analyzer Clock Recovery PWB (A4), Component Location



TYPE NO.	REF	GND	-5.2V
UA733	U1		
1648	U2	4	7
1648	U52	1A	8
10115	U3	1,16	8
10131	U4A	1,16	8
10105	U5	1,16	8
10105	U6	1,16	8
10102	U7	1,16	8
1458	U8		
1,002	U9		
10174	U10	1,16	8
10116	U11	1,16	8
10102	U12	1,16	8
7952	U13		

Figure 7.9. Analyzer Clock Recovery PWB (A4), Schematic (Sheet 1 of 3)

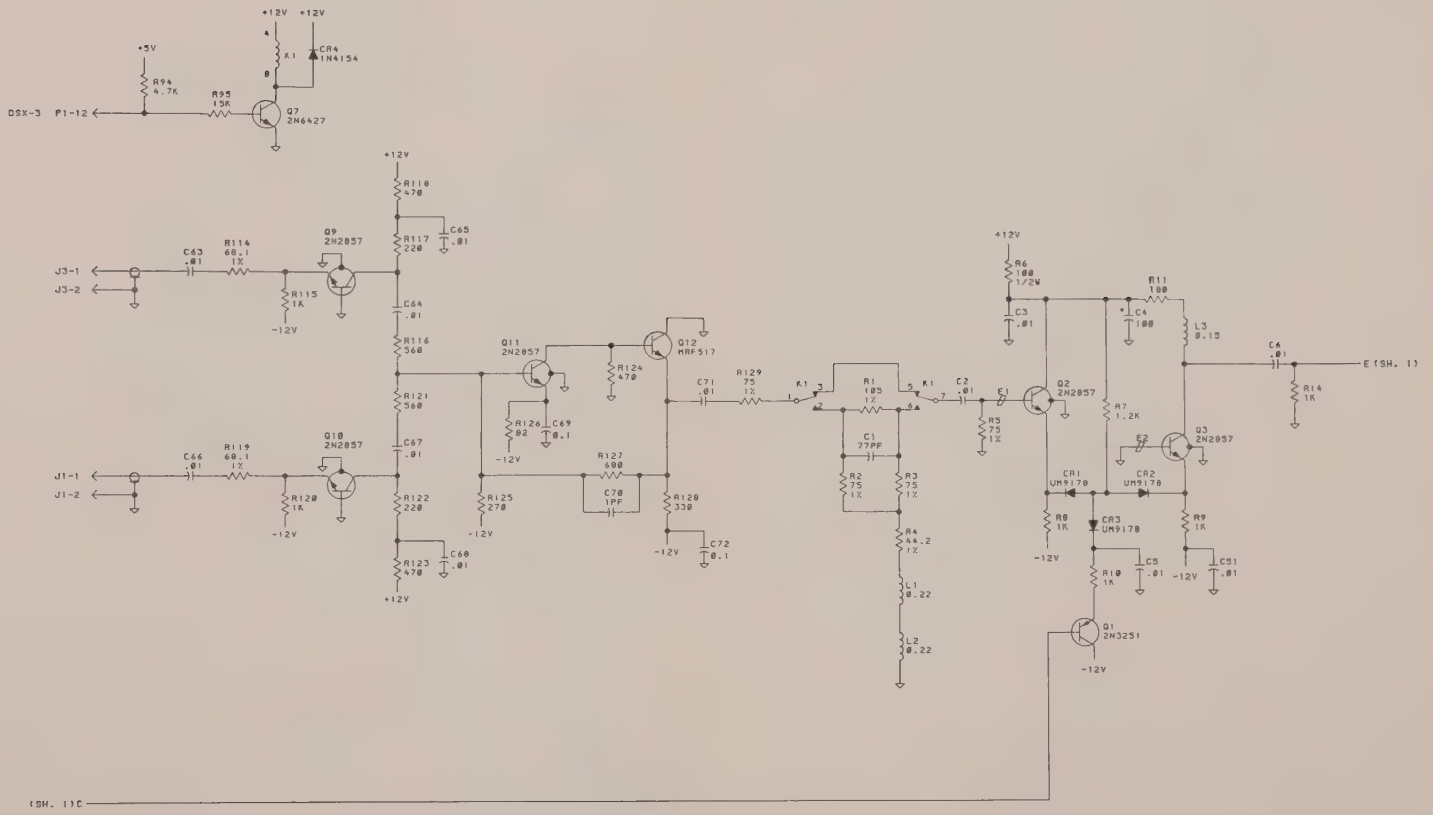
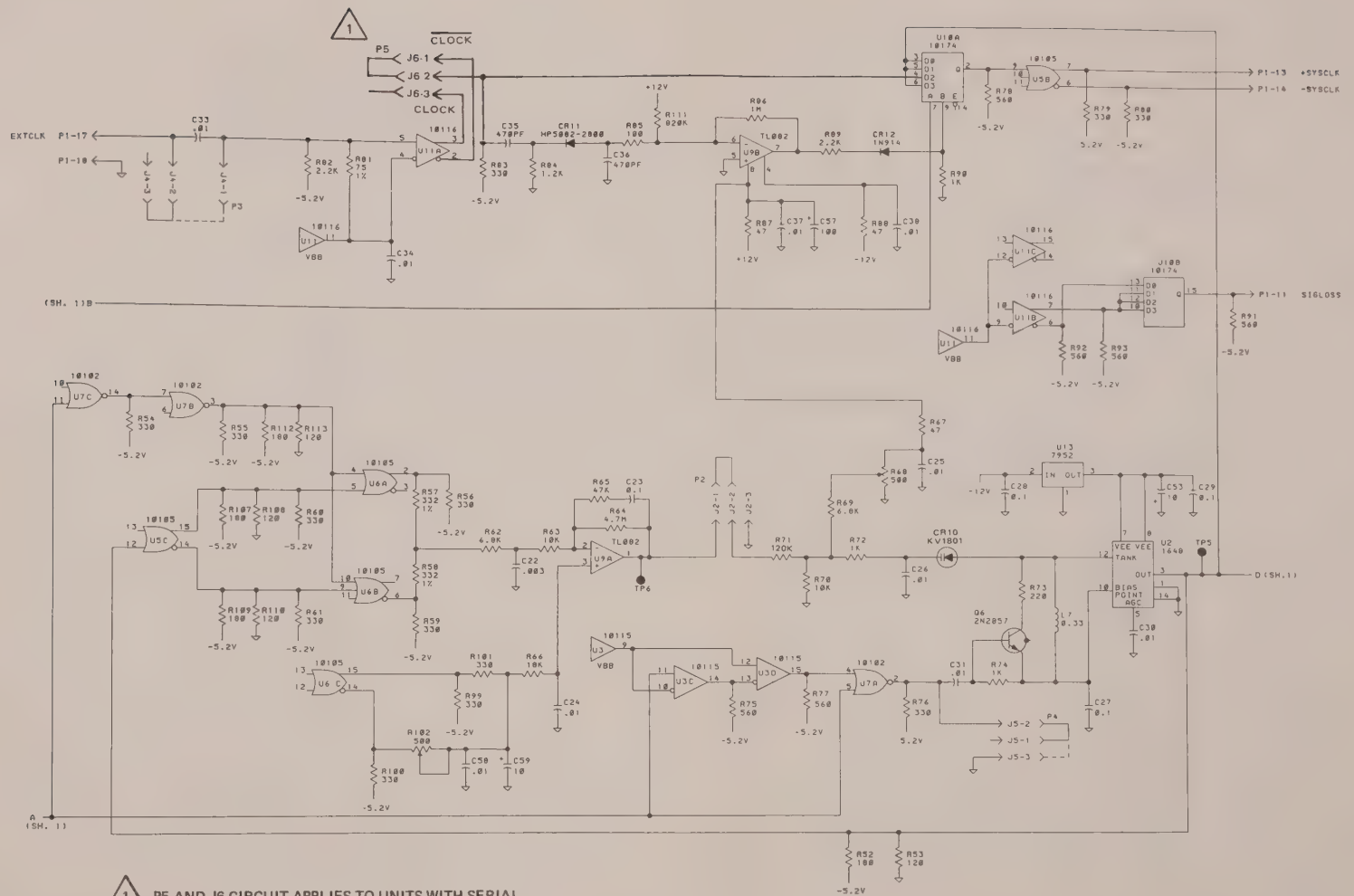


Figure 7.9. Analyzer Clock Recovery PWB (A4), Schematic (Sheet 2 of 3)



1 P5 AND J6 CIRCUIT APPLIES TO UNITS WITH SERIAL NUMBER 153 AND ABOVE (APPROXIMATELY).

Figure 7.9. Analyzer Clock Recovery PWB (A4), Schematic (Sheet 3 of 3)

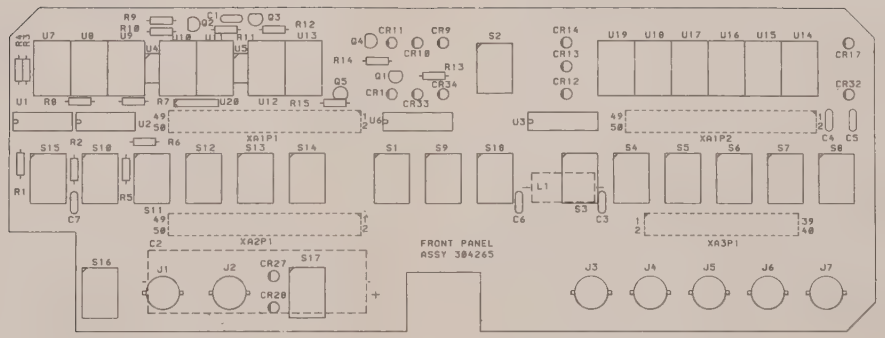
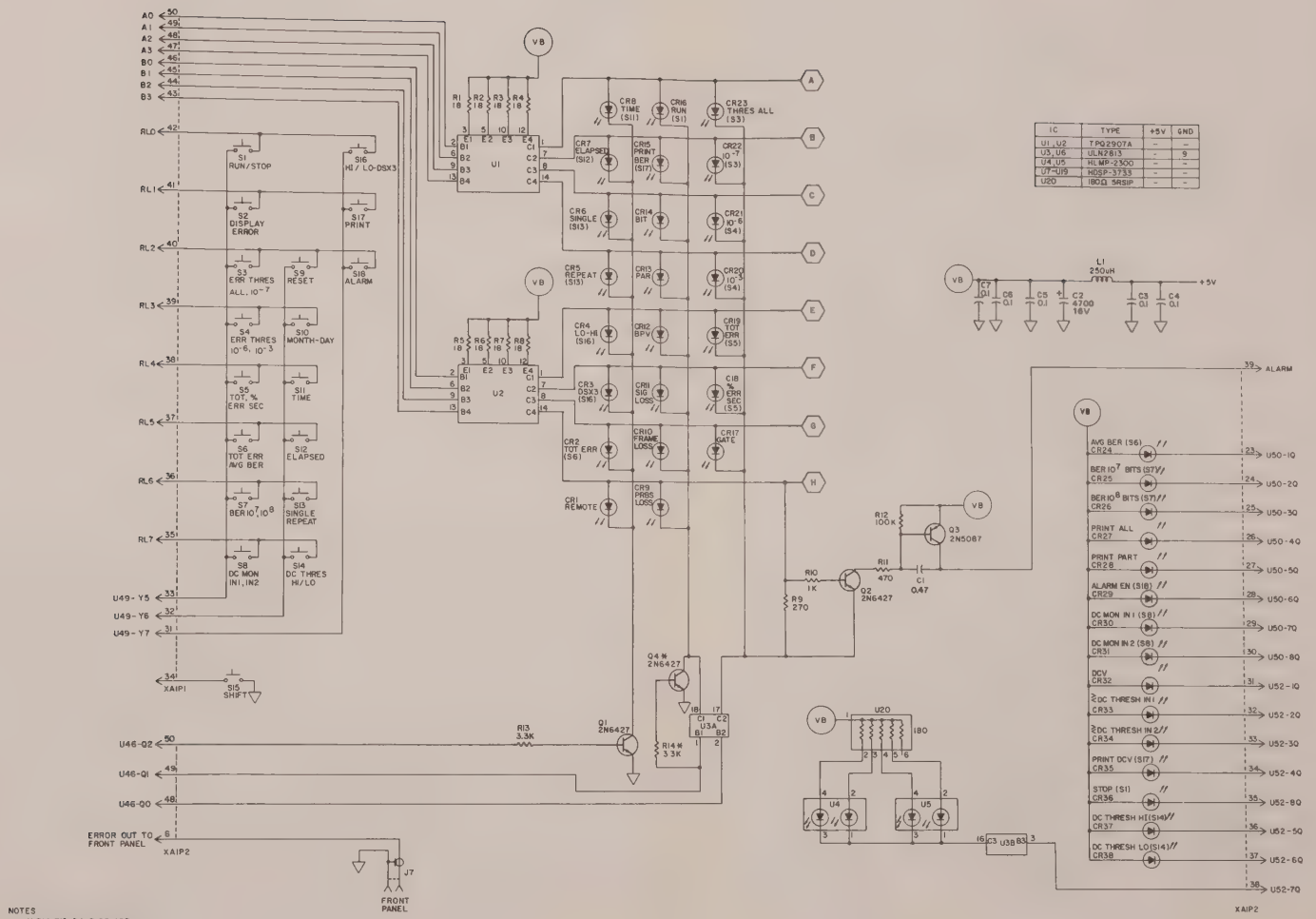


Figure 7.10. Analyzer Front Panel PWB (A5A1), Component Location



NOTES
* R14, R15, Q4, & Q5 ARE INSTALLED ONLY IF ULN2013s ARE USED FOR U3 & U6 IN PLACE OF ULN2813s

Figure 7.11. Analyzer Front Panel PWB (A5A1), Schematic (Sheet 1 of 2)

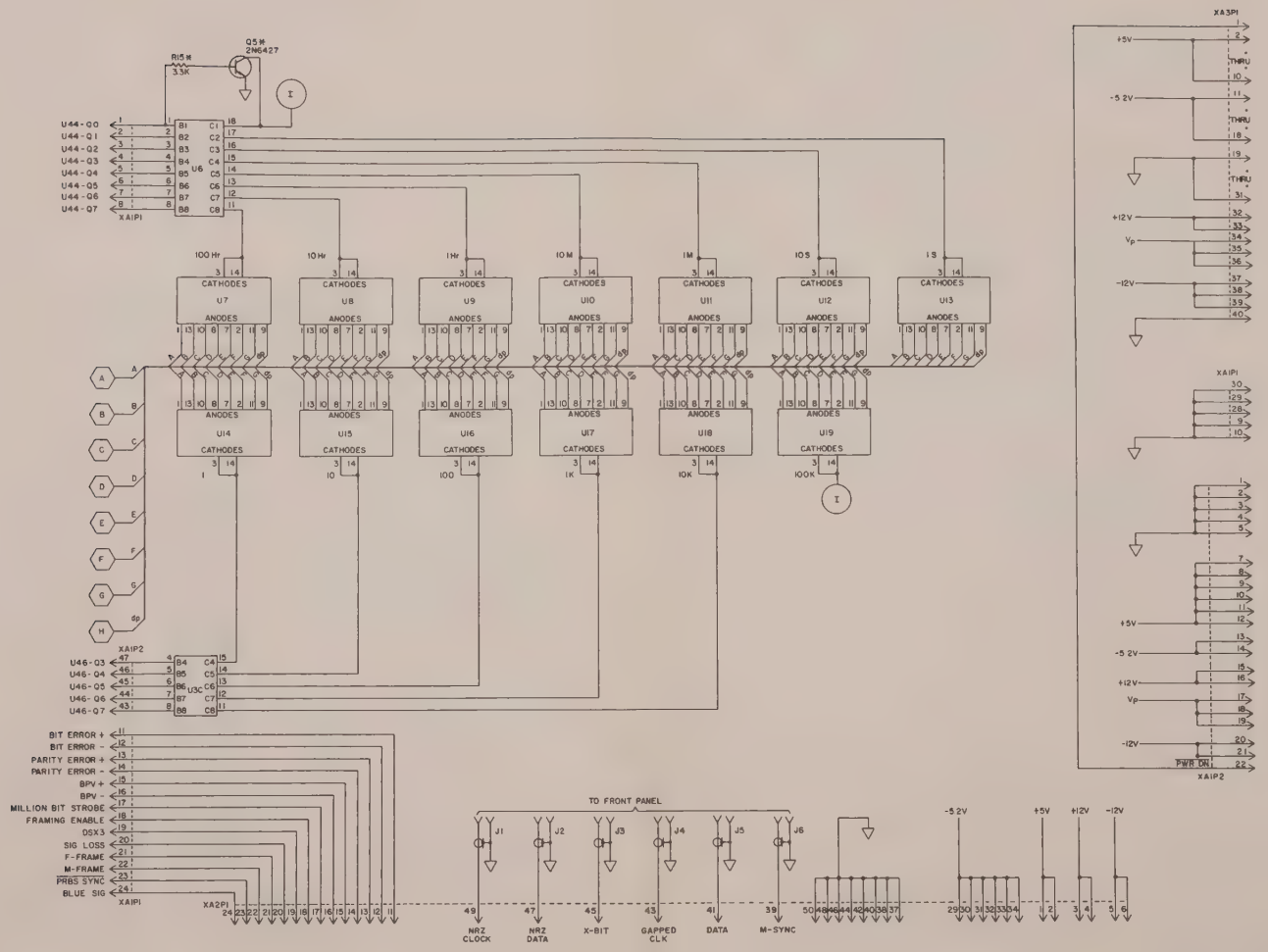
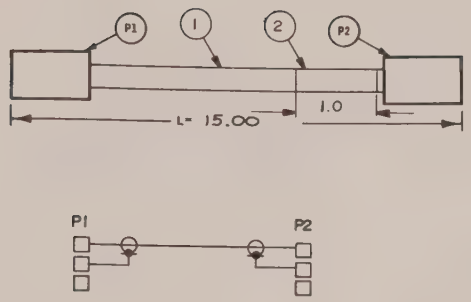
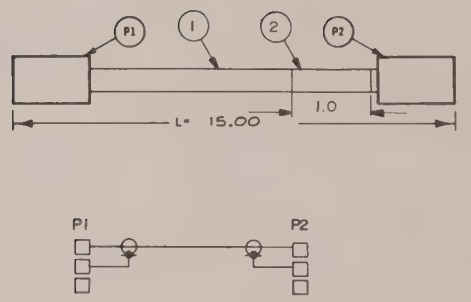


Figure 7.11. Analyzer Front Panel PWB (A5A1) Schematic (Sheet 2 of 2)



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	FSCM NO.
P2	1	84938	CONNECTOR, COAX	75 Ω SMB	51-128-9511	
P1	1	83419	CONNECTOR, COAX	MIN. PNL JACK	J12-4	
2	1	173999	LABEL, SELF-LAMINATING 1.437 X .50			
1	1.8FT	83156	CABLE, COAX	75 Ω	8218	

Figure 7.12. Analyzer Front Panel Cable Assembly (A5W1)



ITEM OR FIND NO	QTY REQD	S-A STOCK NO.	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	FSCM NO
P2	1	84938	CONNECTOR, COAX	75 Ω SMB	51-128-9511	
P1	1	171567	CONNECTOR, COAX	75 Ω BNC	UBJ24-4	
2	1	173999	LABEL, SELF-LAMINATING 1.437 X .05			
1	1.9FT	83156	CABLE, COAX	75 Ω	8218	

Figure 7.13. Analyzer Front Panel Cable Assembly (A5W2)

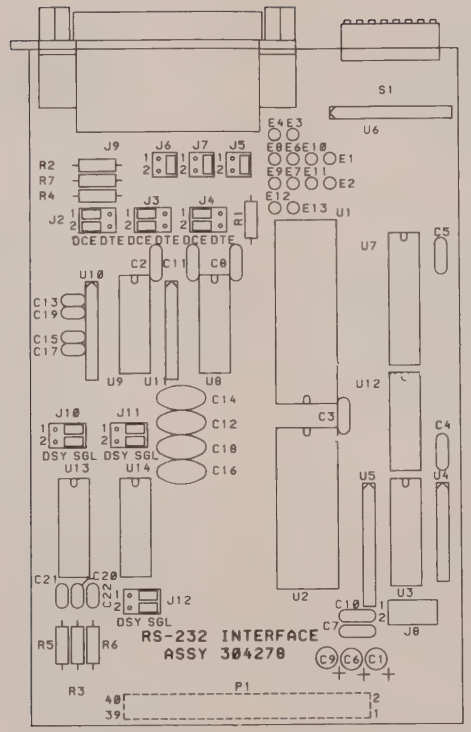


Figure 7.14. Analyzer Option (304278) RS-232 Interface Assembly (A6), Component Location

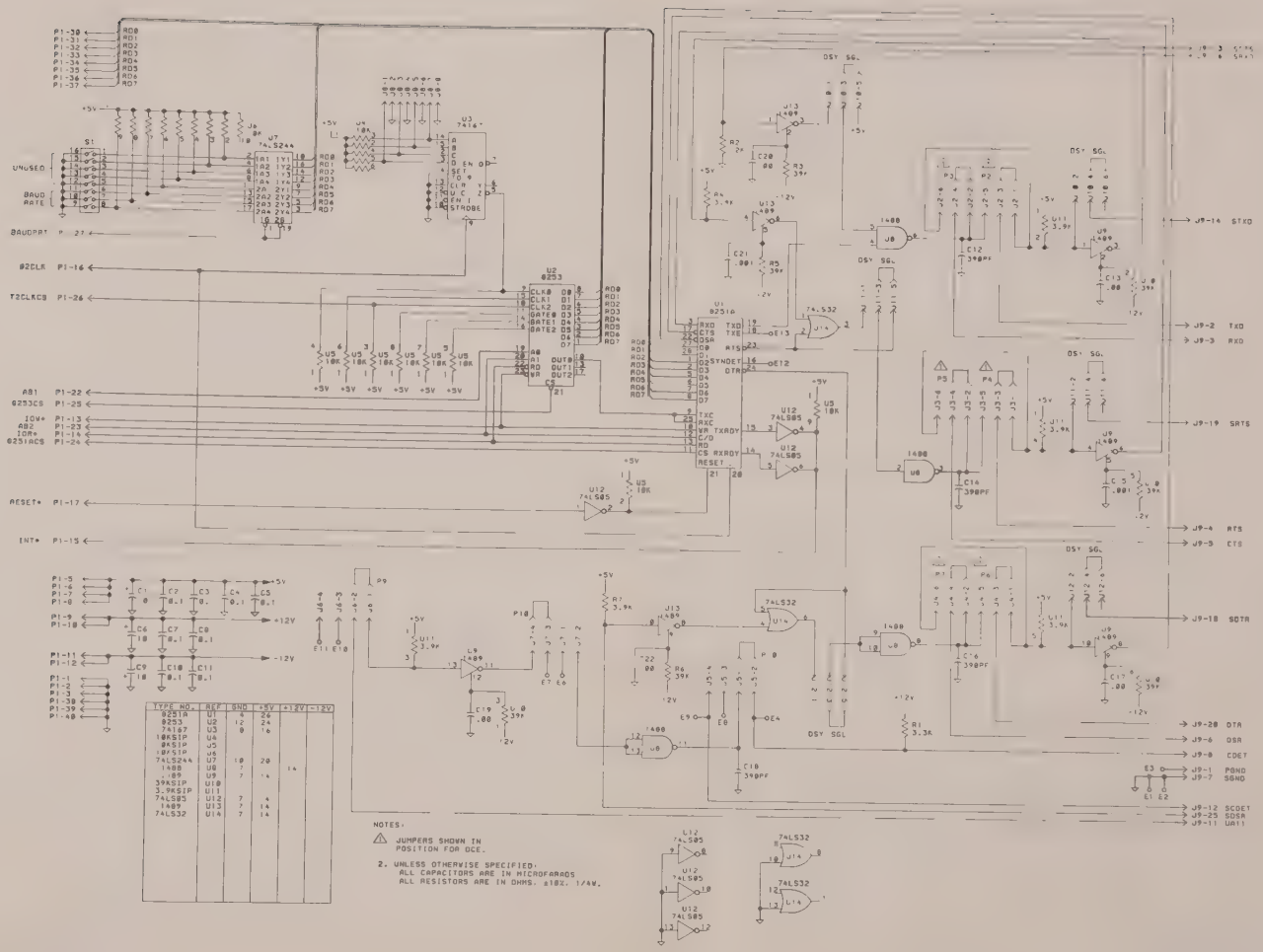


Figure 7.15. Analyzer Option (304278) RS-232 Interface Assembly (A6), Schematic

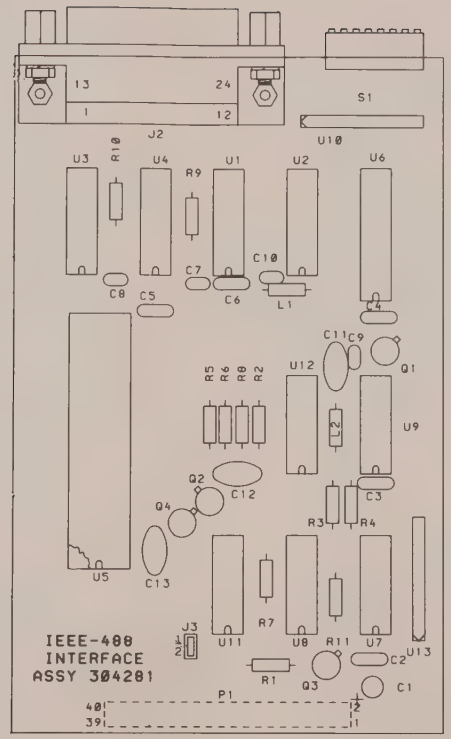


Figure 7.16. Analyzer Option (304281) IEEE-488 Interface Assembly (A6), Component Location

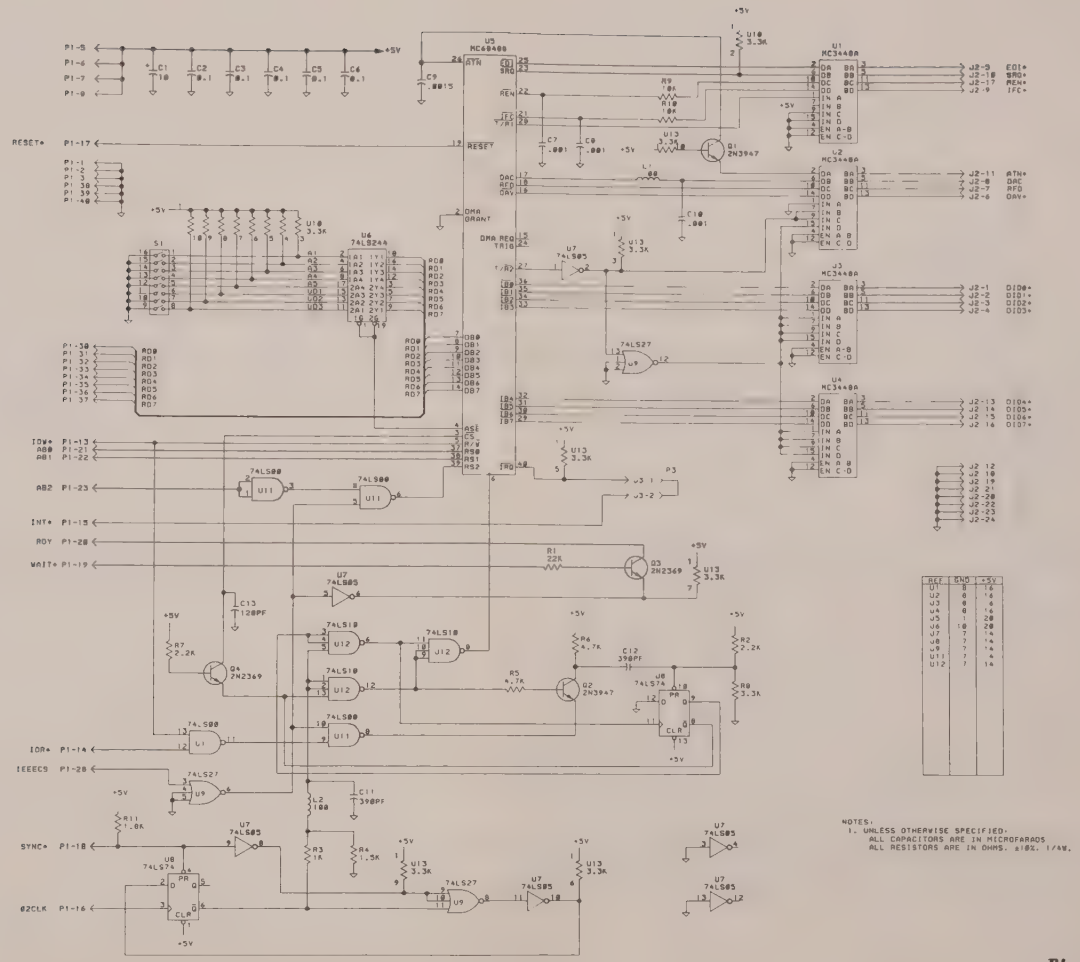
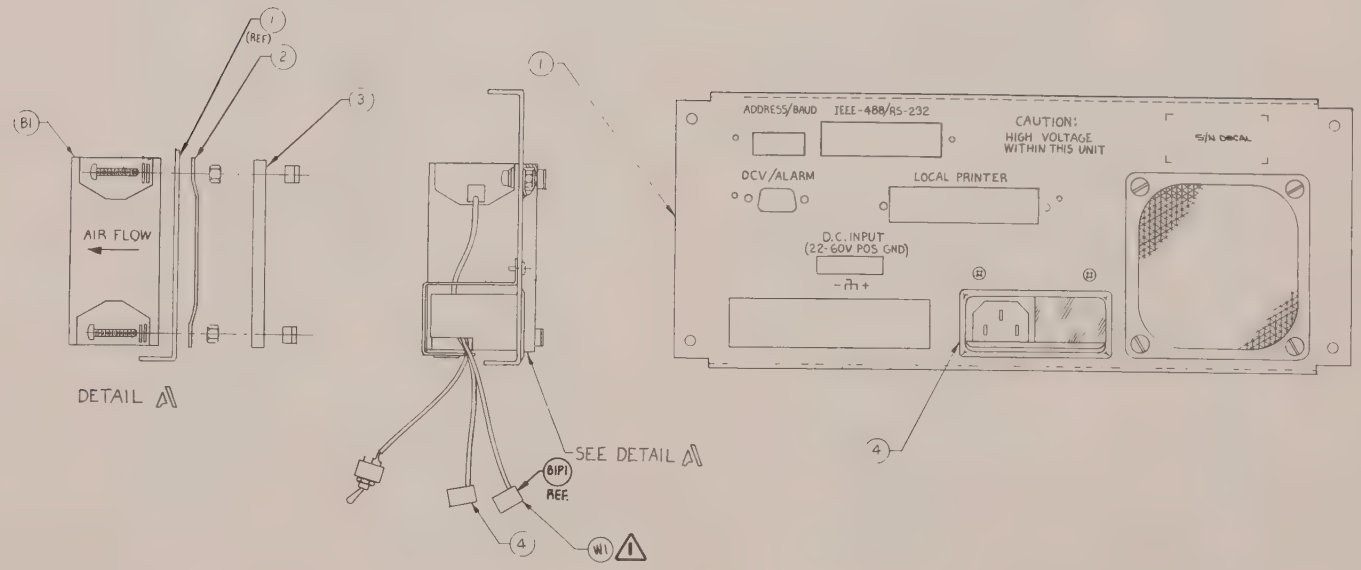
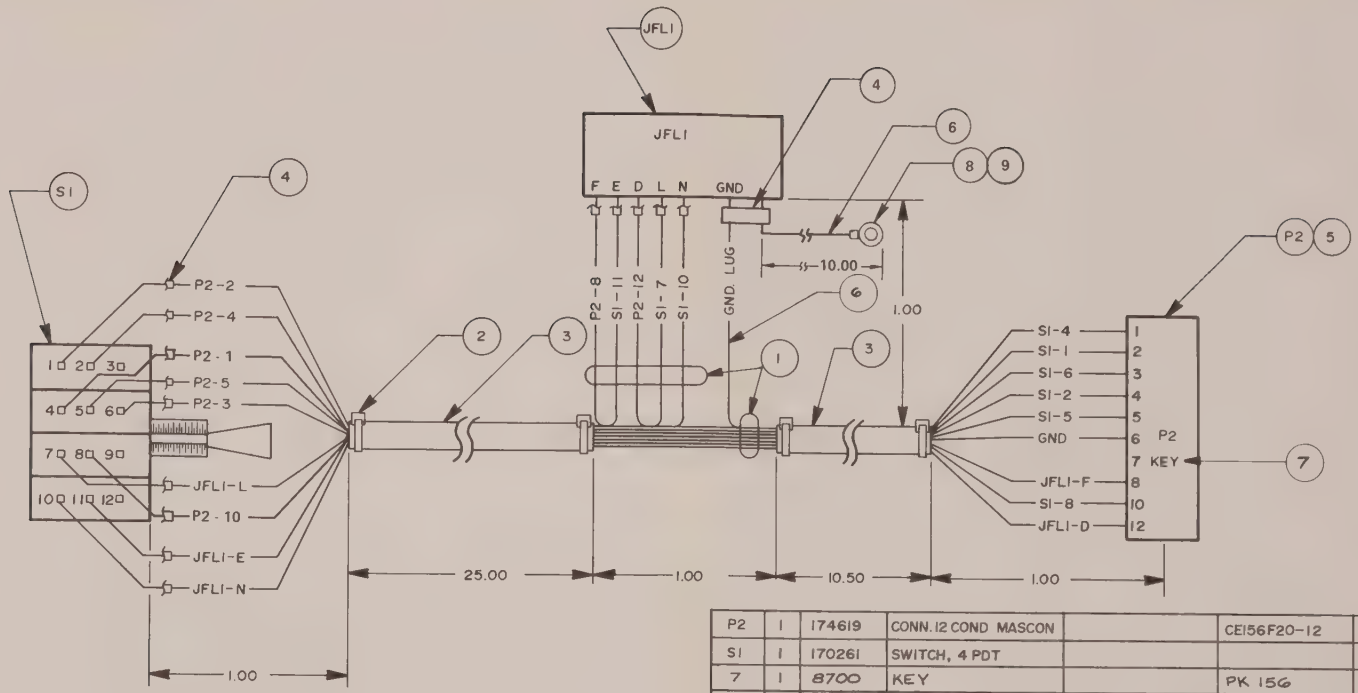


Figure 7.17. Analyzer Option (304281) IEEE-488 Interface Assembly (A6), Schematic



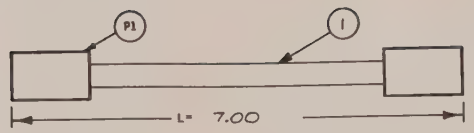
⚠1 W1 IS USED ON EARLIER VERSIONS OF THE REAR PANEL ASSEMBLIES WHERE THE CABLE IS NOT PART OF THE FAN ASSEMBLY.

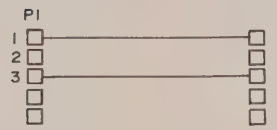
Figure 7.18. Analyzer Rear Panel Assembly (A7)



ITEM OR FIND NO.	QTY REQD	5-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO	FSCM NO
P2	1	174619	CONN. 12 COND MASCON		CE156F20-12	
S1	1	170261	SWITCH, 4 PDT			
7	1	8700	KEY		PK 156	
JFLI	1	83759	CONN., AC, 3 COND.	MALE W/FUSE BLK	& FILTER 6J4	
6	1.5	73427	WIRE, STD. BLACK	20 AWG		
5	1	174620	CONN. COVER		EC156 F12	
4	75FT	75929	TUBING, HEAT SHRINK	.125 ID		
3	3FT	73207	TUBING, VINYL	2 AWG		
2	4	73045	CABLE TIE	4 IN. LONG		
1	30FT	73374	WIRE, STRD., WHITE	20 AWG		
8	1	73013	TERM, INT TOOTH	22 - 18 AWG		
9	.1FT	77936	TUBING, HEAT SHRINK	3/16 DIA		

Figure 7.19. Analyzer Rear Panel Assembly (A7), Powerwiring Harness





P1	1	174618	CONNECTOR,MAS TERM	3 POSITION	CE156F18-3	
1	1	76320	FAN POWER CORD			
ITEM OR FIND NO.	QTY REQD	S-A STOCK NO.	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.	FSCM NO.

⚠1 THIS CABLE IS USED ON EARLIER VERSIONS OF THE REAR PANEL ASSEMBLIES.

Figure 7.20. Analyzer Rear Panel Cable Assembly (A7W1) ⚠1

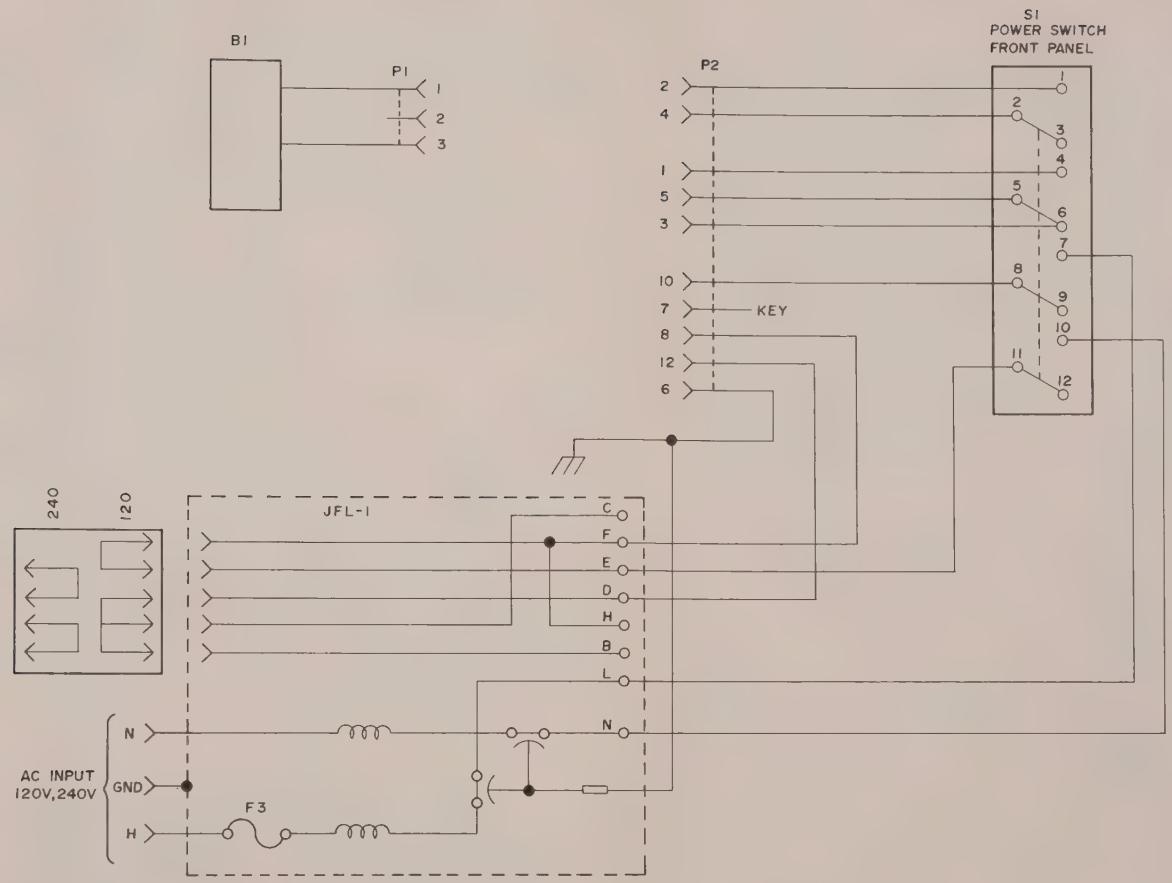


Figure 7.21. Analyzer Rear Panel (A7), Schematic

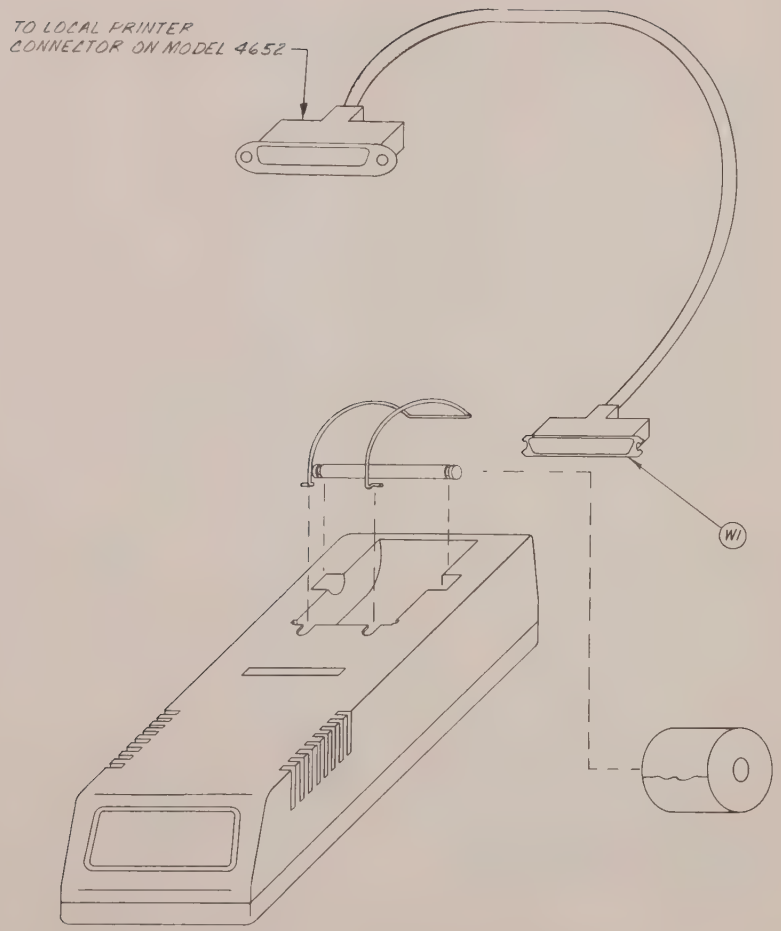
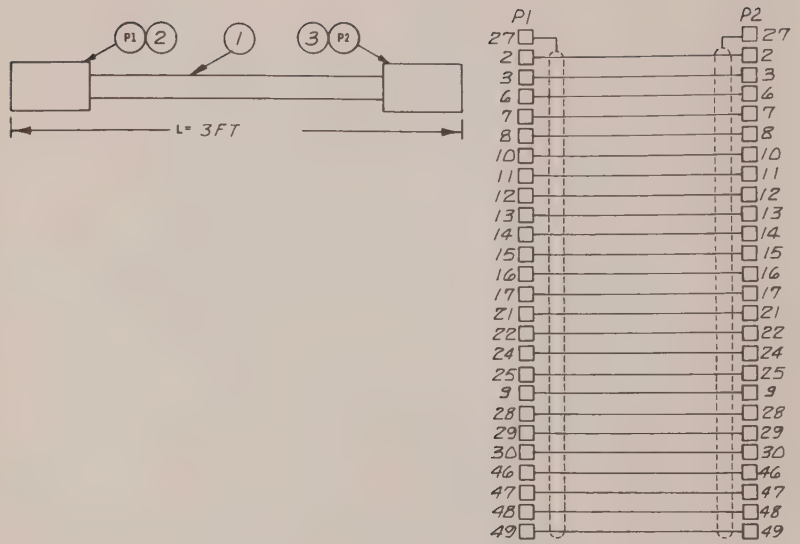


Figure 7.22. Model 4650 Optional Local Printer Components



P2	1	89676	CONN, RECT MALE	50 CONTACTS	552032-1
P1	1	89676	CONN, RECT MALE	50 CONTACTS	552032-1
3	1	85908	CONN, STRAIN RELIEF	STRAIGHT	2-552008-1
2	1	89677	CONN, STRAIN RELIEF	90°	552014-1
1	3FT	170216	CABLE, SHIELDED	25 COND AWG 24	9543
ITEM OR FIND NO.	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO

Figure 7.23. Model 4650 Optional Local Printer Cable Assembly (W1)

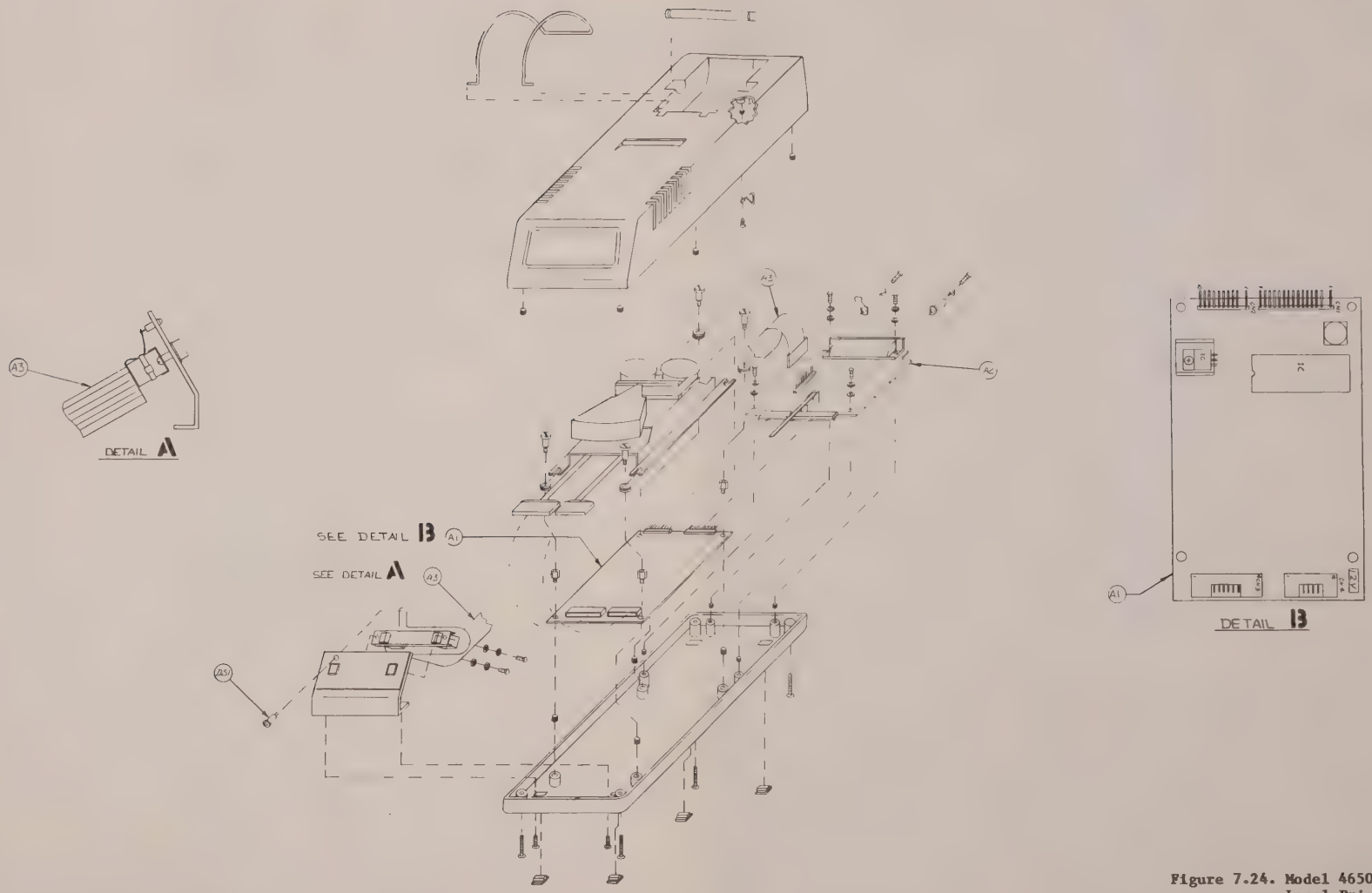


Figure 7.24. Model 4650 Optional Local Printer Mechanical Layout

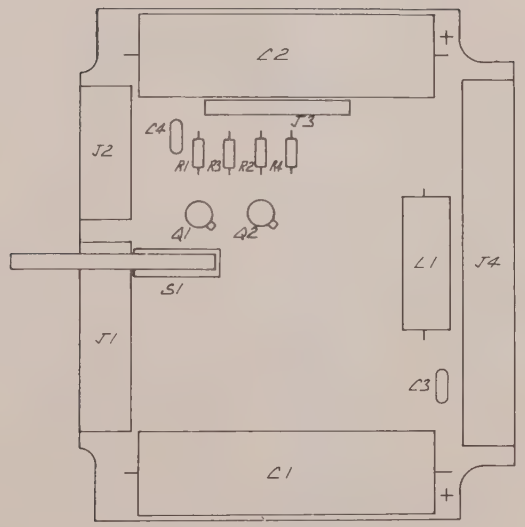


Figure 7.25. Model 4650 Optional Local Printer I/O Assembly, Component Location

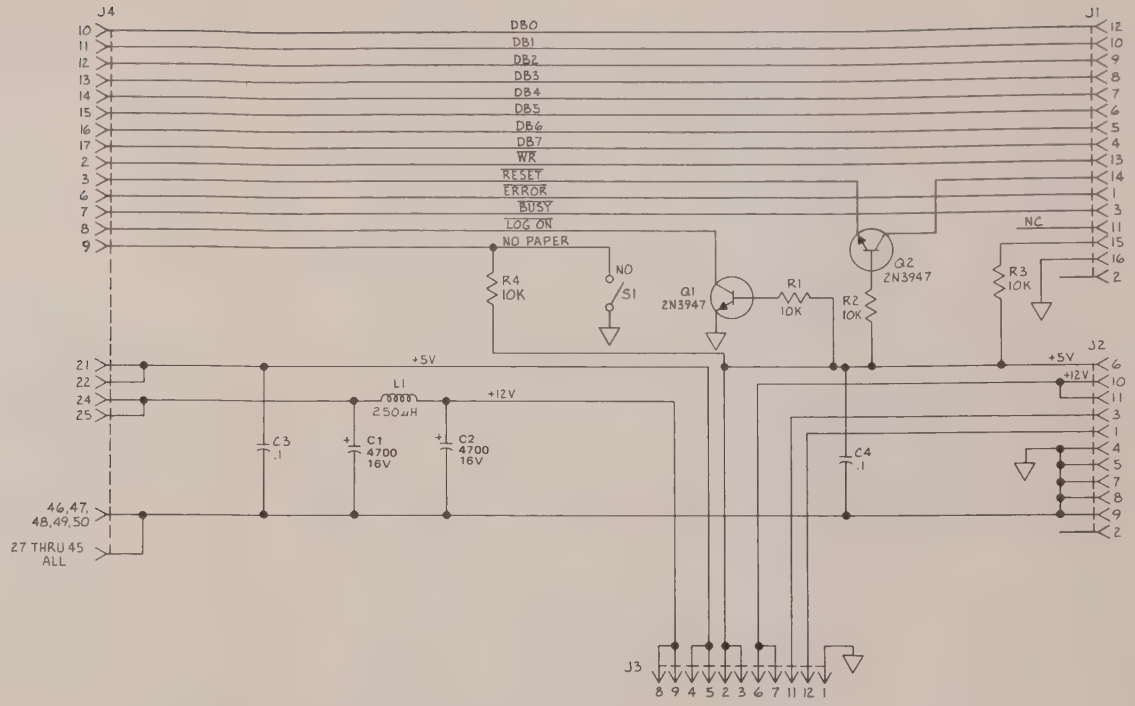


Figure 7.26. Model 4650 Optional Local Printer I/O Assembly, Schematic

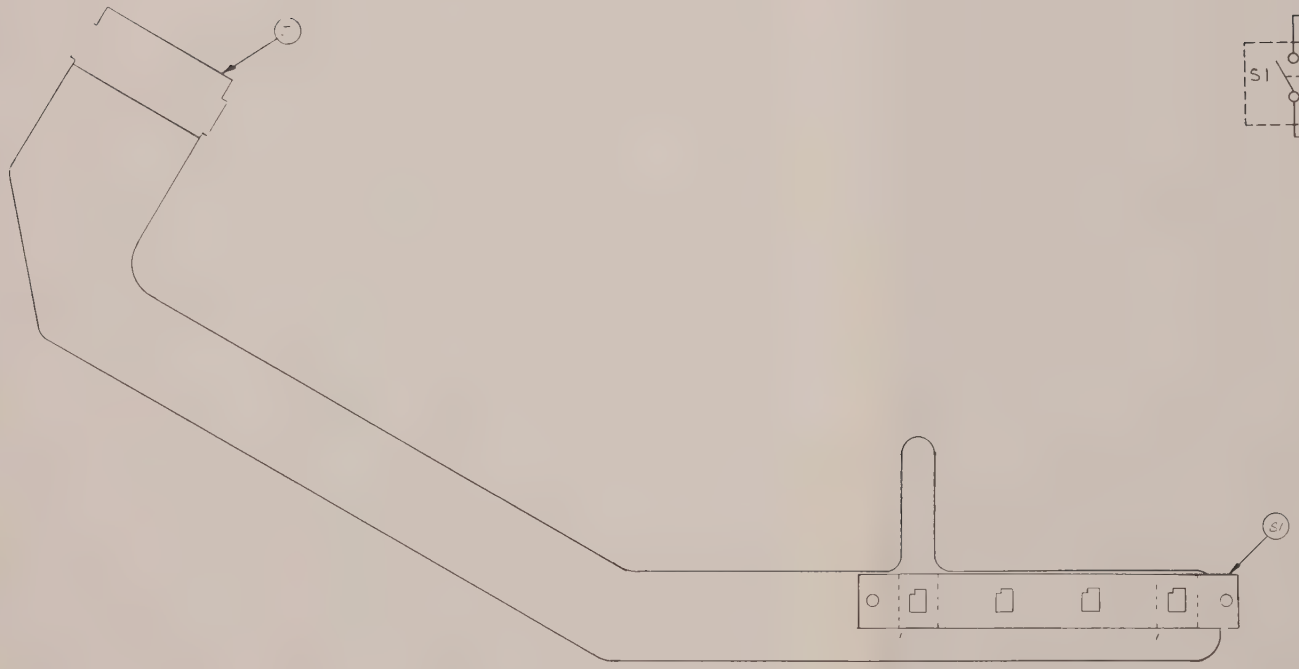


Figure 7.27. Model 4650 Optional Local Printer Flexible Assembly, Component Location

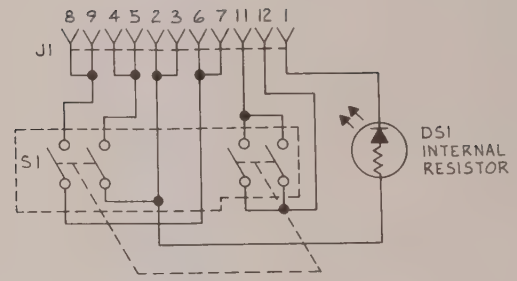


Figure 7.28. Model 4650 Optional Local Printer Flexible Assembly, Schematic

220999
35R053Z

220998

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000 as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42					
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89		10^{-3}	30		10^3
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38	10^{-2}	10^{-4}	40	10^2	10^4
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88					
											10^{-5}	50		10^5
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39	10^{-1}	10^{-6}	60	10^1	10^6
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91		10^{-7}	70		10^7
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44	10^{-4}	10^{-8}	80	10^4	10^8
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99		10^{-9}	90		10^9
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55					
										10^{-5}	10^{-10}	100	10^5	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^6	10^{12}

Instruction
Manual
Update

Manual Update Information

This envelope is provided for filing manual update information such as corrections to text, tables, procedures, new or revised drawings, or special application notes. Please use your own filing method to list the update entries in the blank space below.

This is an interim step to provide our customers with both errata and new information for this equipment while the manual is being corrected.

52478

MP MASTER
MA29821